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64

THE MAGAZINE OF TOMORROW

AUTHENTIC SCIENCE

FICTION MONTHLY

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ARTICLES : Crystal Alchemy, Airborne TV, Research Nuclear Reactors
STORIES : By J. T. McIntosh Jonathan Burke E. C. Tubb, etc.

AUTHENTIC SCIENCE

FICTION MONTHLY

Editor:
H. J. CAMPBELL
B.Sc., F.C.S.,
F.R.H.S., F.B.I.S.

Art Editor:
J. E. MORTIMER

Cover by:
D. A. STOWE

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H.J. Campbell writes

news and views from the editor

MOST PEOPLE SURVEY THEIR YEAR'S progress on the 1st of January, but I'd like to do it right now, while we have the mellow Christmas spirits around us. January brings bills and resolutions and renewals of subscriptions and all sorts of other tiresome things. But Christmas still manages to seem warm and rosy, with brightly lit lamps and hearts, and here and there a genuine smile. A good time. A time when we can justifiably get a little sentimental and push the brittle workaday world aside for a while. Let's do it now.

Let me, for a line or two, forget the trials of being an Editor—the frantic rush to meet printers' deadlines, the frustrating search for mislaid copy, the disappointments when good authors turn in bad stories, the long necessary, but long delayed, economic discussions. Let me forget all that for a space and talk about the human side of the magazine over the past year.

I've had the tremendous pleasure of seeing the magazine improve no end by means of illustrated features. I've found some more new authors who are going places—although it would be truer to say that they found me—and I've had a whole great mass of readers' letters to cheer me on my way. These I like, perhaps, the most. Especially those that tell me details of readers' lives. I'm ashamed to say that I don't find time to answer them all but I

love to read them all the same. There's the guy just around the corner from where I live—though he doesn't know it—and there's the fellow stuck out in Kuala Lumpur or some such distant fester. All these, I like to think, are my friends. And I like to think that they are my friends because they like the way I run this magazine.

I try to make it homely. Over the year, as with other years, I have tried to foster the bond that exists between reader and editor. What pleases me most is when readers refer to *Authentic* as *our* magazine. Because it is our magazine, you know—yours and mine. Together, I think we've done a fine job. I know you think so, too, because you keep telling me so.

Not that I think *Authentic* is perfect. God forbid! If it were perfect we wouldn't be able to improve any more, and we have every intention of doing just that—with your help.

In the great scheme of things that include international politics, world health and a hundred other embracive topics, the progress of this magazine is minute and puny. But to me it's a big thing. And after all, Christmas is a time when personal things take on their rightful grandeur. So—let me wish you all a most merry and happy Christmas, sincerely and with grateful thanks for all you've done for me and *Authentic* over the past year. 'Bye now, H.J.C.

About the cover . . .

. . . Guided Missiles

EVER SINCE PEOPLE FOUND OUT THAT diamonds are composed solely of carbon—the stuff of good clean soot and the lead in pencils—man has wanted to make them. At first it was for the fairly sane reason that crazy people were prepared to pay good money for them. But later, when it was found that diamonds were undoubtedly useful as well as arguably ornamental, man wanted to make them for the very sensible reason that they could help him in his constant search for new ways of controlling his environment. And, because it was a sensible reason, sensible people did the trying.

In the early days all kinds of cranks had a go. They failed miserably—and lost a lot of money while they were doing it. But as soon as rational people got on the job, progress began to be made. It still took a long time and a lot of money. It needed all the power and resources that modern civilisation

could provide—and it required the kind of financially intellectual backing that probably only a highly industrial society could afford.

These things were put together, in association with a good deal of technical know-how, and lo and behold—the scientists at General Electric came up with the real thing. For the first time in history man had made a diamond. Only a tiny one, to be sure, but a diamond, nonetheless.

In some respects the artificial diamond is a little more genuine than the real thing. It used to be said that diamond is the hardest substance known. Now we have to qualify that. *Artificial* diamond is the hardest substance known. It scratches natural diamond!

Anyway, we bring you the latest information and pictures on this new success of science, and you can read and look on pages 23 to 25.

THE SUPER SPRITE

Details of the first liquid-propellant Rocket Engine
to pass a British type-approval test

THE DE HAVILLAND SUPER SPRITE is a rocket engine designed to meet the need for an assisted-take-off unit suitable for general application to military or civil aircraft. It is a self-contained unit which can be either permanently installed in the aircraft or jettisoned after take-off. It is compact and powerful and uses hydrogen peroxide and kerosene or wide-cut gasoline as propellents in conjunction with a solid metal catalyst. It was, in January, 1955, the first British rocket engine to secure Government type-approval.

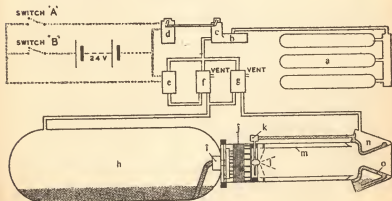
The Super Sprite produces a total impulse of 120,000 lb./sec., 54,431 kg./sec., normally with a maximum thrust of 4,200 lb., 1,905 kg., and a duration of 40 seconds, but both the maximum thrust and the total firing duration can

be altered within certain limits to suit different installations. Unlike rockets using solid propellents the Super Sprite can be shut down at any time during the firing simply by turning off a switch. The engine weighs 620 lb., 281.2 kg., dry, and 1,460 lb., 662.2 kg., when fuelled. It has an overall diameter of 20½ ins., 51.4 cm., and a length of 117½ ins., 297.8 cm.

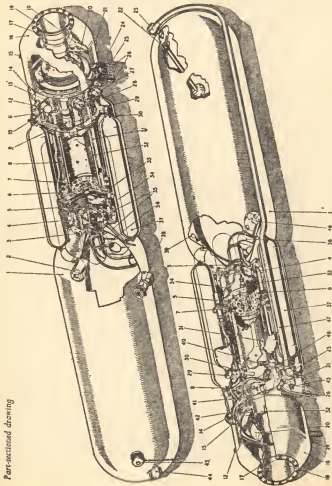
The propellents are contained in two separate tanks, the hydrogen peroxide in a 57-gallon, 259-litre, stainless steel tank (h) situated in front of the motor, and the kerosene or wide-cut gasoline in a 5-gallon, 23-litre, fuel tank (n) surrounding the propelling nozzle. In order to keep the engine as simple as possible there are no feed pumps, the propellents being transferred by the pressure of nitrogen

KEY TO SCHEMATIC ARRANGEMENT OF SUPER SPRITE

- | | | |
|----------------------|-------------------------------|--------------------|
| a. Nitrogen bottles | f. Nitrogen distributor-valve | k. Fuel stop-valve |
| b. Reducing valve | g. Nitrogen distributor-valve | l. Fuel injector |
| c. Safety valve | h. Hydrogen peroxide tank | m. Flame tube |
| d. Electric actuator | i. Peroxide inlet valve | n. Fuel tank |
| e. Solenoid-valve | j. Solid catalyst bed | |



Part-sectioned drawing



- 1 HYDROGEN PEROXIDE TANK
- 2 MAIN TRUSSING MOUNTING FACE, POST
- 3 HYDROGEN PEROXIDE CHECK VALVE
- 4 DISTRIBUTION PLATE
- 5 FUEL CHECK VALVE
- 6 DECOMPRESSION UNIT RETAINING GASKET
- 7 FUEL INJECTOR
- 8 FUEL INLET PIPE
- 9 ACTUATOR
- 10 CONTROL LINKAGE
- 11 HIGH PRESSURE NITROGEN FEED PIPE
- 12 BEAKER ARM POST
- 13 NITROGEN FILLING PIPE
- 14 NITROGEN FILLING VALVE
- 15 FUEL TANK NITROGEN INLET
- 16 FUEL TANK
- 17 EXPANSION JOINT
- 18 COMBUSTION CHAMBER NOZZLE
- 19 FUEL COLLECTOR PIPE
- 20 COOLANT CASSET
- 21 BEAKER ARM STARBOARD
- 22 STACK PIPE
- 23 PEROXIDE TANK NITROGEN INLET
- 24 FUEL FILLING POINT
- 25 NITROGEN AND STATING VALVE
- 26 NITROGEN SERVO PIPES
- 27 NITROGEN FILLING VALVE
- 28 NITROGEN PRESSURE GAUGE
- 29 NITROGEN BOTTLE CONNECTOR
- 30 NITROGEN MANIFOLD
- 31 COOLANT CHAMBER
- 32 FLAME TUBE
- 33 CATALYST ELEMENT
- 34 FUEL INLET PIPE
- 35 PEROXIDE CHECK VALVE DRAIN PIPE
- 36 PEROXIDE COLLECTOR PIPE
- 37 PEROXIDE TANK DRAIN
- 38 FRONT LIFTING EYE
- 39 ELECTRICAL TUNG CONNECTOR
- 40 LOW PRESSURE NITROGEN FEED PIPE
- 41 BEAKER ARM POST
- 42 NITROGEN PEROXIDE FILLING POINT
- 43 FRONT MOUNTING
- 44 PEROXIDE TANK VENT
- 45 NITROGEN FEED PIPE TO FUEL TANK
- 46 NITROGEN FEED PIPE TO PEROXIDE TANK
- 47 MAIN TRUSSING MOUNTING FACE, STARBOARD

gas, stored in the nine bottles (a) surrounding the combustion chamber.

In the aircraft cockpit the controls consist of only two switches (A and B). The first of these is a safety switch (A) which prevents accidental operation of the unit. Until both switches are closed no nitrogen pressure can reach the tanks for, having passed through the reducing valve (b), the nitrogen is retained by the safety valve (c). Operation of the second switch (B) opens this safety valve by means of an electric actuator (d) and nitrogen passes to a solenoid-valve (e) and thence to the distributor-valves (f and g). These latter valves are servo-operated and actuated by the nitrogen pressure, and are so arranged that nitrogen is fed first to the hydrogen peroxide tank. As soon as the tank is pressurised to 14 lb./sq. in., 0.98 kg./cm.², the inlet valve (i) in the combustion chamber opens and the hydrogen peroxide is sprayed onto a solid catalyst bed (j) which causes it to be decomposed into super-heated steam and oxygen gas at a temperature of 500-600° C. The engine, therefore, begins to run "cold" on peroxide alone. Nitrogen is simultaneously fed to the fuel tank (n) but it is not until a pressure of 250 lb./sq. in., 17.58 kg./cm.², is reached that the fuel stop valve (k) opens and allows the kerosene to pass into the combustion chamber through the fuel injector (l). This occurs within approximately one second of the second switch being closed.

The function of the valve system is to ensure that under all conditions hydrogen peroxide precedes fuel into the combustion chamber. An additional feature is that the nitrogen distributor-valves are designed to act as vents for both propellant tanks during filling operations and also throughout the standby period before the unit is fired. This is a further safeguard against inadvertent firing of the motor and in the case of the oxidant tank permits safe storage of peroxide over relatively long periods before firing. The purpose of the reducing valve is

to reduce the 3,000 lb./sq. in., 210.9 kg./cm.², nitrogen storage pressure to a 500 lb./sq. in., 35.15 kg./cm.², feed pressure and to maintain this figure in both tanks during the period of firing. The safety valve, apart from its function of an on-off cock actuated by the pilot's switch, is designed to shut the motor down if a failure of the reducing valve should cause an excessive rise in pressure in the tanks.

Reverting to the combustion, immediately the fuel enters the combustion chamber it ignites spontaneously in the hot oxygen from the peroxide. Ignition will occur only in the hot gaseous products and not with liquid hydrogen peroxide, thus ensuring safe and automatic thermal ignition and obviating the necessity for any separate electrical or other kind of ignition system. This inherent safety factor cannot be over-emphasised, as it removes one of the major hazards of rocket motor operation. Additionally, the gaseous peroxide products constitute a fool-proof purge, preventing the accumulation of any fuel in the chamber, even in the event of any ignition delay.

In order to keep the Super Sprite as simple as possible, the complication of a fully-cooled combustion chamber has been avoided, though as a result the propellant mixture ratio employed is approximately 20:1 (peroxide: fuel by weight) and not the chemically correct value of 9:1. This results in some loss of specific thrust, which is less important in an assisted-take-off unit than for most other applications of rocket propulsion, but results in a drop in combustion chamber temperatures from more than 2,000° C. to about 1,500° C.

The combustion chamber incorporates a flame tube (m) which separates the flow. The relatively cool gases (peroxide products, i.e., super-heated steam and oxygen) travel past the stressed chamber walls while the much hotter combustion products pass down the centre of the chamber. The two streams mix in the final nozzle, the

throat of which is protected by a simple system of regenerative fuel cooling. Baffles (o) in the fuel tank ensure that fuel completely surrounds the nozzle even when the liquid level in the tank has fallen towards the end of a firing.

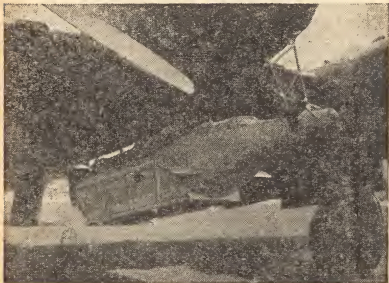
Normal operational procedure is for the pilot to operate the first cockpit switch early in the ground-run and the second as soon as the critical take-off speed has been attained. The switches are left on for a few seconds after the rocket has ceased to fire so that the residual nitrogen pressure in the tank purges all propellant lines.

The Super Sprite is completely self-contained and so lends itself to a jettisonable installation. The decision to develop a jettisonable and recoverable nacelle was taken because it is obviously undesirable for an aircraft to carry the unnecessary weight, although

relatively small, of empty assisted take-off engines after they have performed their task. Such a nacelle has to be capable of being dropped from an aircraft, recovered and, after a minimum of servicing, re-installed for the next take-off. A light-alloy stressed-skin type of nacelle has been designed for the Super Sprite and it is equipped with a parachute and parachute release gear for the descent and a self-inflatable air-bag to cushion the impact of the nacelle with the ground; also there is the electrical equipment for firing and jettisoning.

The parachute gear has been designed to give a rate of descent of 25 ft./sec., 7.6 m./sec., and the nacelle can be released as low as 1,000 ft., 305 m., and at speeds up to 250 kts., 463 km./hr. These figures will probably be improved upon as a result of further development.

Continued on page 48



THE SUPER SPRITE CONTAINER

The way to the Planets

by A. E. ROY, B.Sc., Ph.D., F.R.A.S., F.B.I.S.

7—*Space Medicine*

WITH THE ESTABLISHMENT of the space station man will have set up a laboratory in which to test his ability to cross space, a half-way camp he can pause in, until sure that no danger, known or unknown today, will prevent him leaving planet Earth.

The fast-growing science of space-medicine is concerned with man's physical and mental well-being within and beyond the upper reaches of the Earth's atmosphere. That it is a science and that it is fast-growing may be seen by a glance at the titles of papers on the subject presented at the important Symposium on Medicine and Physics of the Upper Atmosphere, San Antonio, Texas, in 1951, attended by about forty authorities on aeronautics, astrophysics and medicine—"Gravitation and Weight," "Toxicology of Travel in the Aeropause," "Meteoritic

Phenomena," "The Biologic Effects of Cosmic Radiation," "Genetic Effects of Cosmic Radiation," to quote only a few.

Since then many more pieces of research have been completed; flies, mice and monkeys have been sent in V-2 and other rockets into the upper reaches of the atmosphere and the effects of short periods of no-gravity on men have been studied. A number of detailed papers on space-medicine have appeared in the Journal of the British Interplanetary Society, including some on cosmic ray hazards, on the danger of meteors and other possible conditions in space hostile to man's well-being. Again, one of these papers, by Col. P. A. Campbell, U.S.A.F.(M.C.), on "Aeromedical and Biological Considerations of Flight above the Atmosphere," ends with a list of 25 references to other work on this subject.

Now let us see what are some of the hazards that face man in the conquest of space and estimate their possible importance. Naturally, we can deal only with known hazards—any unknown dangers will have to be faced when they are encountered. That is perhaps the most important reason for building an artificial satellite, to be a place wherein man can condition himself to the new environment before venturing into the depths of interplanetary space.

In the design of a life compartment—a “packaged environment”—in a space station or spaceship, many of the requirements humans outside the Earth’s atmosphere will need have already been catered for by the designers of submarines. These include a breathable atmosphere at a suitable pressure, food and water. No danger there—but wait! If the life-compartment is in conditions of free-fall, its inhabitants will soon suffocate amid plenty of oxygen as they lie asleep unless forced ventilation is installed. Normally, the air we exhale rises and colder air containing oxygen takes its place, but in free-fall convection currents do not occur. Thus ventilation

is essential to provide a current of air. Again the no-gravity condition may be found too unpleasant to be sustained for more than a short period. It has been suggested by physiologists that the only human organ to be affected directly will be the balancing mechanism of the inner ear. There, three semi-circular canals arranged at right-angles to each other register accelerations. In addition, the utricle and the saccule are believed to register gravitational pull. Some physiologists have pointed out that in free-fall, uncomfortable and distressing effects may be experienced. Giddiness, vertigo and vomiting may result from confusion arising from the bodily sensation of falling together with the visual signals of “not-falling.” Fortunately this danger, as space-station designers are well aware, can be removed by substituting centrifugal force for gravity.

Research on humans and monkeys subjected to high accelerations in centrifuges, sleds, rockets and rocket planes show that the future pilots of three-stage satellite vehicles operating from ground to orbit will not take higher accelerations than they can

stand. H. Haber and others have shown that the physiological accelerations suffered to enable a rocket to reach escape velocity may range from 3g for 9 mins. 31 secs. to 10g for 2 mins. 6 secs. In studies at the Aero-medical Laboratory at Wright Field, Ballinger and co-workers found that even untrained volunteers tolerated accelerations of up to 10g for comparable periods of time without a g-suit if they were in semi-prone and supine positions. Colonel Campbell reports that these individuals, while experiencing such accelerations, were able to converse in monosyllables, their vision was clear, they were mentally alert, were able to respond to visual and auditory signals, and they could still move hands, wrists and ankles.

One danger that has been apparent to the earliest space-travel enthusiasts—and their critics—is the chance of a meteor collision with the ship. In past years any lecturer in astronautics who omitted to deal with this problem could be sure that, at question-time, some individual would arise and triumphantly ask: "Yes, but what about meteors?" Question two was always:

"But surely you must realise that a rocket can't work in a vacuum?"

In recent years, as a result of work by Grimminger, Ovenden, Langton and others, a reasonable estimate of the danger of meteors may be made. In the past it has been maintained on the one hand that any spaceship venturing beyond the Earth's atmosphere would be immediately riddled by meteors; on the other, the assertion has been made that thousands of years might elapse before a hit was registered on a body as small as a spaceship.

Grimminger, of the Missiles Division, Rand Corporation, published a detailed study of this problem in 1948. It falls into two parts: the first is the structural problem of calculating the penetration of a meteor of given mass, size and velocity; the other is the astronomical problem of estimating the numbers of meteors of various sizes and masses. Neither of these problems has exact solutions; some uncertainty is unavoidable, since extrapolation from known data is necessary.

Meteors of all sizes are continually entering the Earth's atmosphere. Most of them are destroyed by the

heat generated in their passage through the air. A few are large enough—or small enough—to arrive as meteorites at the Earth's surface. The large meteors are small in number; the number of tiny meteors is fantastically large. For example, if we take the number of meteors striking the Earth in a period of 24 hours, then there are about 28,000 of mass 4 grams, while there are about a million million of mass one ten millionth of a gram. It is interesting to note that there is a lower limit to the mass. Meteors small enough are repelled out of the Solar System by radiation pressure.

It is then possible to calculate the chances of a meteor of any given size striking a body of any particular cross-sectional area. It is found, for example, that for a space station of exposed area 1,000 sq. ft. in the vicinity of the Earth, the average number of hours between collisions with meteors whose masses are of the order of 4 grams is about one thousand million. On the other hand, only about two hundred hours elapse between collisions with meteors whose masses are of the order of one twenty millionth of a gram. Thus it

becomes necessary to calculate the power of penetration of meteors of various masses.

In the vicinity of the Earth a ship may expect to encounter meteors travelling with velocities around 200,000 feet per second. Even a small mass travelling with this velocity possesses tremendous kinetic energy.

Grimminger derives curves to show the thicknesses of dural and steel that would be penetrated by stony meteors of any magnitude travelling at such velocities. He finds that, for a dural hull of thickness between 0.02—0.05 inch, even meteors of mass one twenty millionth of a gram would be dangerous. A steel hull is of somewhat better protection.

In general, as Clarke points out, for a spaceship of such construction, there is one penetration per 3,000 hours or, on a 100-hour lunar trip, 1 chance in 30 of being hit. The case for a space station is, of course, much worse. However, there are several remedies. The hull may be armoured with half-inch steel. There would be then 1 penetration per 30,000 years or so. A more feasible remedy was suggested by F. L. Whipple—a meteor collision screen. If a

meteorite collides with a sheet of thickness comparable to its diameter an explosion results in which both meteor and a small area of the sheet are vaporised and ionised at very high temperatures. Hence Whipple suggests surrounding the hull of the station or ship with a millimetre-thick sheet of metal about one inch from it. Investigations by him and Langton show that the meteor bumper should effectively safeguard a ship or station. In any event, the occasional penetration by a meteor should not prove fatal to the inhabitants of a space station. Even if the impact went unnoticed, instruments would ring warning bells if the air pressure fell by more than a certain fraction and, after sealing off the damaged section of the station, a patch would be provided to close the hole left by the celestial visitor.

We must now consider briefly what may be the most serious problem in space-medicine, the effect on human beings of unshielded cosmic rays. Dr. Heinz Haber, of the Department of Space Medicine at the U.S.A.F. School of Aviation Medicine, said recently that this is still a

highly controversial field. At sea level no hazard exists, and it has even been suggested that cosmic rays may play a major role in evolutionary change. But in the higher layers of the atmosphere, above 70,000 feet, exist high-energy particles, including heavy primaries, ranging in atomic weight between 4 and 60, that would plough through the living tissue of spacemen. In so doing they would dissipate their energy by damaging and ionising cells. Dr. L. R. Shepherd, of the British Interplanetary Society, has analysed the situation, both from the standpoint of physics and biology. His preliminary estimate was that under the worst conditions met in flight in and above the atmosphere, the ionisation produced in exposed tissue would be only about one fifth of that which is tolerated in the case of personnel exposed continuously to gamma and X-rays. But when he took into account the intense ionisation due to the heavy nuclei of sodium, silicon, iron, etc., he found that the biological effect may exceed that which can be tolerated in continuous prolonged exposure. He suggests that if exposures of the order of a year are contemplated,

some form of shielding would appear to be necessary.

But these figures, as Dr. Shepherd emphasises, are by no means certain. Further laboratory experiments and further cosmic ray observations are needed. In addition, the effects of radiation on human beings require to be known more exactly. Some step towards this knowledge has been the calling together, at Harwell, recently of scien-

tists of the United Kingdom, America, Canada and Sweden to plan methods of obtaining information about the long-term effects of radiation. The information required relates to populations, particularly those living in areas where the normal background radiation is higher than the average. This information will undoubtedly help in estimating more accurately the cosmic ray hazard facing man in space.

NEWS

A new guide to the Heavens

A NEW LANDMARK IN astronomy has been reached with the recent publication of the first 200 sections of the National Geographic Society—Palomar Observatory Sky Survey, a gigantic sky atlas revealing new stars, galaxies and super-galaxies existing in three quarters of the heavens. Work on this project, nothing less than a map of the universe, has been proceeding for six

years, and it is hoped that the full atlas, containing 1,758 sections, will be completed by 1956.

The man behind this work, the eccentric German genius, Bernhard Schmidt, has been dead some twenty years. His revolutionary system of optics led to the building of the great 48-inch Schmidt camera with which the survey is being made.

For years Schmidt worked on a problem that had baffled astronomers for almost a century, ever since the first photographs of celestial bodies were taken. Because of the system of optics in use, pictures of star fields or of extended objects were clear and sharp only at their centres; the further you went towards the edge of the plate the more blurred the image became. Finally, the solution came to Schmidt in what the unthinking usually refer to as a stroke of genius, but what in reality was probably the way most discoveries or solutions are made, namely, a final clarification of a problem thought about long and intensively.

Schmidt saw that a telescope required a corrector plate, a thin glass lens in the upper end of the telescope, through which the starlight would pass before reaching the mirror. The lens is shaped to refract light passing through it in such a manner that it, on reflection from the mirror, reaches the photographic plate perfectly focused over the entire surface.

For the first time wide-field photographs of the heavens could be taken, making possible the mapping of the entire sky. The 48-inch Schmidt at Mt. Palomar, though unable to photograph objects more than one third of the distance the 200-inch giant can penetrate, can take on a single plate an area 500 times greater. Interesting and mysterious objects, such as different types of galaxies, seen little larger than pin-points on the Schmidt plates, can be then photographed on a larger scale by turning the 200-inch Hale telescope on them. Some plates so far taken contain as many as 10,000 galaxies of stars; others reveal in their bewitching beauty the great glowing gas clouds of our own galaxy, or the dark, star-obscuring regions of dust and gas scattered throughout the Milky Way. The survey, when completed, will give astronomers an invaluable guide to the heavens, not only in the near future, but for decades to come.

The atlas's price? Only £700!
A.E.R.

Airborne Television

FOR CHECKING TURBOPROP ICING

AIRBORNE TELEVISION HAS BEEN USED to observe de-icing tests on the Bristol Proteus turboprop engine, power unit for the Britannia airliner.

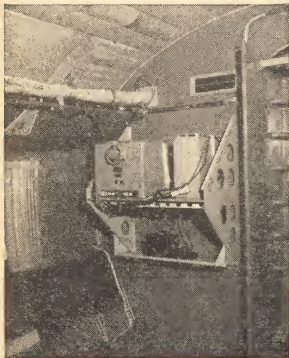
A small Pye camera mounted in the port engine nacelle of the Proteus-Ambassador "flying test-bed" relayed pictures to a 14 in. television screen inside the aircraft, enabling technicians to watch the tests while they were actually in progress.

The tests, part of the programme for the Britannia's Certificate of Airworthiness, showed the engine to be virtually immune from the effects of icing conditions. They were completed in only twenty hours' flying.

Without television, at least ten times as much flying would have been necessary. Use of an ordinary cine-camera would have meant months of work, involving a slow, step-by-step procedure—the film recording each stage of the tests would have had to be processed and examined before proceeding further.

In order to create artificially the kind of icing conditions which might be met in service, the Proteus-Ambassador was fitted with a water-spray grid positioned directly in front of the port engine and supported by a light tubular structure attached to the forebody of the fuselage.

The grid was, in effect, a kind of "watering rose." From a group of 37 nozzles it sprayed water—supplied from a 135-gallon tank in the rear of the aircraft—straight at the



spinner and cowlings of the Proteus. Anti-icing protection for the grid itself was supplied by hot air tapped from the starboard engine.

At full flow the spraying grid delivered about 500 lb. of water an hour at the Proteus air intake.

To ensure that the water found its way into and around the engine, tests were first carried out with dye-impregnated water. Before the actual icing tests began, the effect of the spraying installation on the aircraft's behaviour was also examined, both in normal flight and with one engine inoperative. It was found to cause negligible drag.

Mounted inside the Proteus engine, the Pye television camera was focused on the entry guide vanes. Fan-cooled and flexibly supported, it completed the tests without replacement of the cathode tube—a tribute to the engine's freedom from vibration, the flying characteristics of the aircraft, and the durability of the camera itself.

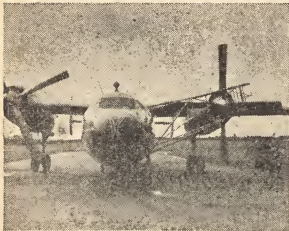
On the 14 in. monitor screen inside the cabin, observers were able to watch the effects of icing conditions. When the anti-icing system was inoperative they saw ice deposits

building up on the entry guide vanes, often taking the form of lumps of ice about $\frac{1}{2}$ in. wide by $3\frac{1}{2}$ in. long. From time to time, the deposits would break off and disappear into the engine. However, at no time did the behaviour of the power unit give the slightest cause for anxiety, and the engine was accelerated and decelerated satisfactorily under these conditions.

In the most severe case, with the anti-icing system *not* in operation, ice accretion on the vanes caused a loss of only three per cent. of engine power after about 17 minutes. When the system was switched on, the severest deposits were disposed of in a few seconds. The tests took place at heights varying from 10,000 to 30,000 ft.—a range within which icing may be encountered in temperate and tropical zones. Temperatures as low as minus 44 degrees C. were encountered—lower than the worst case called for in ARB requirements.

The main reason for the virtual immunity of the Proteus from the effects of flying in water-laden atmosphere lies in the anti-icing properties inherent in the design of the engine.

The reverse-flow air intake system ensures that the air drawn into the engine first passes through heated cowl surfaces, with the result that any ice that forms is reduced to a comparatively harmless state before passing into the compressor itself. It is this natural resistance to the effects of the worst atmospheric conditions, combined with the use of the highly efficient thermal anti-icing system protecting the



Cont. on page 36

ZIRCONIUM

by W. W. BYFORD, B.Sc.

THAT NECESSITY IS THE mother of invention is a hardy old proverb, true in most things and certainly in things scientific, particularly so if we remember that the word invention used to mean discovery. With the ancient philosophers, part of the investigation and formulation of a truth was the establishment of whether or not its converse was true. The converse of our proverb reads: "Invention is the mother of necessity," and it is, indeed, as true as the proverb itself. Whoever invented the wheel made necessary the invention of a lubricant.

The story of the development of the usefulness of zirconium is very much a story of the making of discoveries which were themselves made necessary by discoveries of the Twentieth Century. We have always had zirconium with us. In the Book of Revelations we find

reference to jacinths as among the precious stones which garnished the wall of the city when John saw the new Jerusalem, in his vision, coming down out of Heaven as a bride adorned for her husband. The jacinth, later called a hyacinth, was a variety of the group of gemstones known as zircons. These we know now to be silicates of the metal zirconium. When Man's knowledge was small his desires were simple and it was sufficient for him that zircons were good to look at, and he used them to make ladies who were good to look at a little more so, and very well they did the job. Zircons can be pale yellow or deep orange or green. One of them is the grey and smoky jargon of Ceylon. Some are brown, but under the action of strong sunlight or heat become green or bright blue. A colourless form of zircon, when cut, has a lustre which rivals in

brilliancy that of the diamond so that it is known as a Matura diamond.

The mention of precious stones, of course, brings thoughts of rarity, but though mineral crystals of zirconium silicates of gem quality are scarce enough, the metal zirconium is by no means rare. Among all the metals in the crust of the Earth, zirconium ranks ninth in abundance. Man has access to more zirconium than he has to lead, zinc or copper. It is found in rocks of almost every type. Limestone, sandstone, granite and its derivative clay form the major part of the Earth's surface between them. Zirconium is found in extractable quantities in granular limestone, in sandstone and in granite, especially in the variety of granite known as pegmatite, besides being found in schists, chlorites and the sands of the sea shore. Zirconiferous sand is particularly plentiful on certain beaches in Australia where, in 1948, no less than seven companies were shovelling up the sand to extract zirconium from it. In the United

States, beaches in Florida have proved equally productive of zirconium, and sea shore sand today supplies most of the world's zirconium. Earlier sources were individual crystals sorted out from various rocks in Madagascar and Brazil, where crystals were found occasionally up to fifteen pounds in weight, though normally very much smaller. Brazil has also not unimportant deposits of a mineral known as baddeleyite, a naturally occurring form of zirconium oxide.

Zirconium is yet another metal the existence of which was first indicated by Klaproth. In 1789 he carried out an analysis of some of those jargons from Ceylon and obtained an earth which, until then, had not been obtained from that or any other source, and which he later christened Zirkonerde. About thirty-five years later Berzelius isolated a black powder which consisted mostly of zirconium. The metal continued to be regarded as a very rare element until 1892, when the Brazilian baddeleyite was first investigated.

Other deposits of zirconium oxide were found in Norway, and it was realised that the metal was not as scarce as had been thought. However, the chemistry involved in obtaining the pure metal in a ductile state was such that the price was of the order of £75 per pound, even when produced by the iodide process discovered by the Dutch chemists, van Arkel and de Boer, in 1925. Although the metal itself remained so long an expensive and unused commodity, the oxide of zirconium began to be used increasingly between World War One and World War Two for various purposes.

We all know that glass must be heated or cooled gradually if it is not to crack. This is because it is a poor conductor of heat on the one hand, and on the other it expands considerably on heating and contracts on cooling. It is, therefore, unsuitable as a container for many chemical purposes. Silica, on the other hand, has a very low coefficient of expansion and will stand up to very high temperatures without melting

or decomposing, and so the chemist has, for special purposes, made such things as mercury vapour pumps and crucibles with fused quartz. Zirconium dioxide has also a very low coefficient of expansion and will endure even higher temperatures than will silica. It has, therefore, been used in the manufacture of crucibles for work at high temperatures and for linings of furnaces. For much the same reasons, zirconium sands find use in replacing ordinary sand, which is straight silica, in making very high temperature castings.

You may remember from the first article in this series, that the otherwise disappointing metal, beryllium, found use for making windows in X-ray tubes because, since its atoms are very light, X-rays readily pass through it. The atoms of zirconium are just about ten times as heavy as are those of beryllium and it is, therefore, highly absorbent of X-rays. Zirconium oxide can be passed through the human body without any poisonous effects. It is, therefore, an ideal substance to be

swallowed by patients whose intestinal tracts need to be investigated, since zirconium oxide will throw dark shadows in an X-ray photograph.

It was after World War Two that zirconium metal, rather than compounds of zirconium, came into its own, and that for two reasons. The efforts to harness and control the power released by Uranium 235 in the atom bomb discovered new necessities. Zirconium proved to be the answer. The second factor was the invention of the Kroll process, which made the extraction of zirconium much less costly.

You will remember how, in the article on uranium, the significance of neutrons in the atomic pile was considered. In operating atomic reactors, much depends upon what happens to the neutrons produced by fission. Some of them are used up in hitting other fissionable atoms to continue the reaction chain. Others are lost in various ways. Some will be captured deliberately by moderators to prevent the chain reaction from taking place too rapidly.

Some will be lost in various parts of the actual structure. Some can be used for creating useful radio-active isotopes of normally inactive elements for use as tracers for medical, chemical, metallurgical and various other fields of scientific investigation. Some, however, can be used to make non-fissionable atoms become fissionable and, therefore, of use as sources of further atomic power.

It is rather as though you could design a locomotive engine which used coal, not only to supply the power to pull the train from London to Edinburgh, but also to manufacture during the journey some of the coal which would feed the boiler on the journey back to London. By fissionable atoms we mean atoms which can, by absorbing neutrons, be split in two to give a lot of energy and some more neutrons. If some of the new neutrons convert non-fissionable atoms into fissionable atoms on such a scale that the new fissionable atoms are more numerous than the fissionable atoms used up, we apply the term "breeding" to

the process. We now have the train leaving London and arriving at its destination having manufactured on the way more coal than it has burned, so that in Edinburgh it can offload a few tons and return to London and do the same.

We have, of course, a long way to go before we solve the problem of making all our neutrons go just where we want them to go, but obviously a first requirement is a material with which to construct certain parts of our apparatus, and that material must not be, itself, a thief of neutrons. The tendency of the atoms of any given element to absorb neutrons is measured by what is known as the "absorption cross-section." This can be considered as a measurement of the area over which an individual atom can be effective as an absorber of a neutron. Remembering how small an atom is, you would not expect to measure it with ordinary units. Instead, a unit known as a "barn" is employed. A barn is the area enclosed in a square each side of which is one billionth

of a centimetre long. According to one story a barn was so called because, compared with some of the things it was meant to measure, it was much too big, "as big as a barn," in fact. If the absorption cross-section for an atom of a given metal is a lot of barns, then that metal is of no use for constructing atomic reactors.

Zirconium, in an impure state, is a very different thing from pure zirconium. Samples of impure zirconium powder were distributed by post in the United States in ordinary envelopes. Several franking machines in mail stations were ruined as a result of explosions which occurred as these envelopes passed through. When the cross-section was determined for commercial zirconium it was found to be a lot too high for reactor purposes. The cross-section of the metal hafnium was found to be rather more than a hundred barns. The commercial zirconium contains about 3% of hafnium as an impurity. Making due allowance for the presence of hafnium, further

calculations showed that the cross-section for pure zirconium was less than a quarter of a barn. Zirconium had come into its own; it is the ideal material for the construction of nuclear reactors.

One effect has been to put a lot of the subsequent discoveries about zirconium in the State Secret class, but, nevertheless, the production of the metal is now measured in tons instead of pounds, and also the metal has become available for other purposes.

It is highly resistant to acids, including very strong nitric acid such as is used in some fuels for rockets, which can, therefore, be contained in vessels made of zirconium. It is equally immune to corrosion by organic substances and is, therefore, quite a safe thing to have around in living tissues. When the human cranium is so damaged by disease or injury that replacement of bone is necessary, very thin zirconium sheeting is as good a material for the job as any, and it is increasingly coming into use for that purpose, besides being em-

ployed for various surgical instruments.

Small quantities of zirconium have been found to increase the facility of working of magnesium alloys, and aircraft are already in flight, the manufacture of which was made easier on this account.

In industry, various modifications of the ordinary wireless valve are in use for specialised purposes. It is very important that these shall be entirely free from active gases. Small pieces of sheet zirconium, or zirconium powder coatings on the grid, absorb such gases.

Doubtless, as more and more zirconium becomes available, many new uses for it will be found in normal metallurgical fields, but with the exhaustion of the world's supplies of coal and fuel oil already coming into view in calculable time, its importance in the development of atomic power is of prime significance. It already plays its part in the construction of the atomic submarine, as it will certainly do in the fulfilment of all the dreams of the atomic age.

CRYSTAL ALCHEMY

FROM THE U.S.A. COMES NEWS OF another milestone in the progress of science—the successful synthesis of diamonds. Not just one attempt by a small firm but the news that over a hundred runs in the Research Laboratories of the giant General Electric Company have produced diamonds some of them being water white and transparent as the best gems.

When the news was released there was a fall in the value of diamond shares on the Stock Exchange, but apparently General Electric have no intention of entering into competition with the diamond combines. For you will have to wait some years before large, first-class gem stones are produced. The majority of those already synthesised are yellow due to impurities, and the largest one measures a sixteenth of an inch in length.

Why, you may ask, is General Electric interested in diamonds? This work is part of a long-term investigation into the properties and synthesis of materials at very high temperatures and pressures connected with cutting and refractory materials as metal carbides. Carbides are being used to an ever-increasing extent to withstand the extreme conditions met with in rocket nozzles and the corrosive melts now being used in high temperature chemistry.

It took four years' work before the first diamond was produced and a gigantic pressure furnace capable of reaching $2,760^{\circ}\text{C}$. and a pressure of over 100,000 atmospheres, near that found 250 miles below the surface of the Earth, had to be built. These temperatures and pressures have been produced in laboratories separately but never, as now, together.

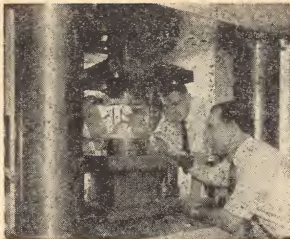
General Electric are interested in the diamonds from the industrial viewpoint. They are used in the finest and most accurate tools and the size is often unimportant. Many coloured diamonds are crushed to give the diamond dust used in diamond abrasives. The U.S.A. imports ninety per cent. of its industrial diamonds, value £12 million a year, and they are an indispensable part of any modern technology.

It is 125 years since the first claim to synthesise diamonds was made but, until now, there has been only one claim that has not been disproved after attempts to repeat them. Many have been out-and-out swindles, but there have been many reputable scientists who have made attempts and failed, leaving their notes to help those who have now succeeded.

General Electric produced their diamonds by heating an organic material to several thousand degrees under a pressure of 56,000 atmospheres for 16 hours and the greatest weight of them produced during one run was .02 of a gram. In spite of this, these synthetic diamonds cost only twice that of the natural stones and any large scale production would soon cut the cost tremendously. By a process of controlling the growth of the crystals it will be possible to increase their size, and one day the cost of diamonds may approximate their true value.

The basic problem in the synthesis of diamonds is the fact that carbon can exist in two forms, as an infinite, three dimensional diamond crystal, and in the form of graphite where the carbon atoms form widely separated layers. At ordinary temperatures and pressures the graphite is the most stable type, as it contains less energy.





THE NEW 100-TON PRESS

Diamond is metastable, having the tendency to change into graphite but the reaction is so slow as to be non-existent at ordinary temperatures. It is very much faster at higher temperatures, and a diamond will change to graphite if it is heated to $1,700^{\circ}\text{C}$. in the absence of air. However, the change of graphite to diamond is also slow, even at high pressures and temperatures, and it is because of this that most of the early attempts failed.

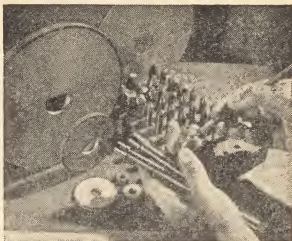
There are two ways of manufacturing diamonds—by starting from pure graphite and altering its crystal

lattice or by breaking down a carbon-containing compound and building up a lattice anew.

At first it would seem that the graphite to diamond conversion is the most promising; it is the way that diamonds are formed in the Earth's crust. They crystallise out from molten iron very slowly between 45 and 250 miles below the surface where the temperature is about $2,000^{\circ}\text{C}$.

and the pressure is 140,000 atmospheres.

From the energy contents of the crystals it is possible to calculate the conditions necessary for the change,

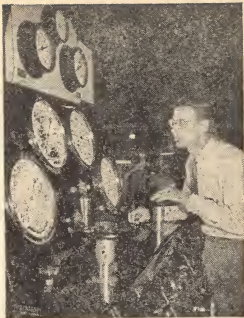


GRINDING AND POLISHING TOOLS

and when this was done it was found that there can be no possibility of converting graphite into diamond at any pressure below 13,000 atmospheres. At room temperatures 16,000 atmospheres are needed, and at 1,300° C. 40,000 atmospheres are required, the needed pressure rising as the temperature is raised. But the change is so slow, even at high temperatures, that it is the controlling factor and all attempts to use this method were doomed to failure. Attempts have been made to convert graphite by heating from room temperature to 3,000° C. at 30,000 to 96,000 atmospheres, but there was no success.

Moissan's method of crystallising carbon from molten iron has also been tried, but again that did not work. The trouble was that the chemists couldn't afford to wait for a few thousand years.

The second method, liberating carbon by a chemical reaction under extreme pressure, so that the atoms can form into the metastable lattice without first forming graphite, is probably the way by which the General Electric researchers succeeded. It was first tried by Hannay in 1880 and it seems likely that he did manage to make some very small diamonds. His specimens turned up in the British Museum a few years ago, and X-ray analysis showed that they were, in fact, diamonds of the very rare type II that would be expected to result from the very fast crystallisation that must have occurred. He hit on the idea of decomposing paraffin and bone oil in the presence of lithium metal. Now, bone oil contains com-



THE PRESS CONTROLS

bined nitrogen that reacts with lithium to form lithium nitride, and molten lithium nitride is the most virulent solvent known to science; it is possible that by a strange freak of chance he managed to find the right conditions to manufacture diamonds some seventy years before they were rediscovered as part of a planned search.

One by one, Nature is yielding her secrets to Man, and just as some of the newer synthetic gems are more brilliant than diamonds, long the symbol of brilliance, soon there may be even newer gems and crystals harder than diamonds, possibly more beautiful in strange ways that we cannot as yet imagine.

Photos: General Electric

Scientists now probe fundamental problems with—

RESEARCH NUCLEAR REACTORS

BY KENNETH JOHNS

THE COMING USE OF atomic power for everyday commercial use is now accepted by the man in the street with a shrug and the comically apt malapropism: "I suppose they'll be running it soon with the gas and water up our street."

Scientists working at nuclear research establishments know how close to reality that casual statement is, and how far away it really is in terms of the work they have to do to bring it to fruition. At the present time nuclear reactors are being found more and more work to do, and they are making their peculiar attributes felt in every branch of science and industry. The main value of research nuclear reactors is as a source of neutrons and gamma rays produced by the fissioning of uranium-235 by

thermal, or slow, neutrons. They are like giant ovens in which brews may be cooked and transmuted in a special atmosphere.

The fuel for powerful nuclear reactors is the basic problem; but this, enriched uranium-235, is already plentiful in the U.S.A.—they have recently offered 220 lbs. to the United Nations, enough for fifteen research reactors to be built and kept running for several years. The recent announcement that breeder reactors have been successfully operated in the United Kingdom is another pointer to the eventual successful solution of the problem. Universities, research institutes and industrial laboratories will soon be owning and using their own nuclear reactors as another basic research tool.

In everyday terms, the con-

ception of a nuclear reactor is deceptively easy—the problems arise when those theories are put into practice. The uranium-235 atoms are split into two fragments, each carrying millions of electron volts of kinetic energy as they are flung violently apart. The chain reaction is kept going by the average of two and a half neutrons also split off the atom and slowed down by collisions in the moderator until they, in their turn, can cause more fission.

The fission fragments are radio-active, with half-lives varying between a fraction of a second and thousands of years. They disintegrate, giving beta particles and gamma rays containing about five million electron volts of energy.

Not all of this tremendous output can be used. The fission fragments and the beta particles cannot be used directly because both are quickly absorbed in the reactor and their energy is wasted as heat which has to be removed. From the viewpoint of the research scientist, the most useful are the fast neutrons, slow neutrons and gamma rays, all of which are radiations that can be employed in research. Figures for a moderate-sized research re-

actor show that if it produces 1,000 kilowatts of heat it uses up 1.35 grammes of uranium-235 per day and produces 37×10^{16} neutrons every second above those needed to continue the fission reaction. Only 6 per cent. of the total energy produced is in the form of gamma rays. Even then, the majority of the radiations—neutrons and gamma rays—are absorbed in the concrete shielding and only a very small part of them can actually be used.

The basic design of all reactors consists of a central core of uranium-235 and a moderator, this being the fission zone where is found the greatest intensity of radiation. The fuel can be in the form of a water solution of a uranium salt. Or, sometimes, it is in the form of metal sheets or rods. Moderators are water, heavy water and graphite. To keep the extremely high temperatures under control cooling must be efficient. If the moderator is a liquid it is circulated through a heat exchanger; if not, a separate cooling liquid or gas is pumped through special channels. The core is surrounded by a light material, such as beryllium, which scatters neutrons well but does

not absorb very many, thus cutting down the wastage of neutrons from the core by returning them.

The whole core is surrounded by the biological shield to safeguard the scientists, and is pierced by holes through which control cables enter and others through which some radiation is allowed to escape during experiments. Some holes go right through the reflector to the core. This shield is of composite construction. Neutrons are best absorbed by such light elements as hydrogen, boron or lithium. Gamma rays require heavy elements. A typical shield is made up of three feet of water—hydrogen atoms—surrounded by an outer shield of seven feet of concrete containing barium.

The speed of the neutrons varies between 1 and 10,000 miles per second and their intensity is measured in terms of the neutron flux, the number of neutrons in a unit volume multiplied by their average speed. The neutron flux of a powerful reactor is 10^{14} neutrons per square centimetre per second. The intensity of gamma radiation is measured in roentgens per hour.

The scientists must be able to control this research tool.

The ratios of the amounts of neutrons and gamma rays may be varied by altering the position of the tube leading into the reactor. The different components can be separated from a beam of the mixed radiation. Pure gamma rays are obtained by passing the beam through a solution of borax in water, when the neutrons are absorbed; thermal neutrons by passing the beam through layers of graphite and bismuth, and fast neutrons by passing it through natural uranium when the thermal neutrons are absorbed with the formation of fast ones.

An ingenious device has been developed so that physicists may obtain particular speed neutrons. A neutron beam is passed through a "chopper" which consists of two rotating discs with slots so arranged that only neutrons with the required speed from slots in the first disc travel the distance in time to pass through the slots in the second.

All neutrons have wave properties, just as have electrons, and they can be diffracted by materials just like X-rays; but they do not affect ordinary photographic emulsions. To record photographically their experiments

scientists had to find a way to overcome this difficulty. The answer shows again the versatility necessary to keep the modern research scientist one step ahead. A sheet of indium is placed over a photographic plate. The bombarding neutrons form gamma rays in the indium which pass through to the plate and give a normal image.

Neutrons have the great advantage in research work over X-rays that they are scattered by very light atoms—even by hydrogen. This fact is now being used to find the position of hydrogen atoms in complex organic molecules such as proteins and plastics, and in crystals. This is impossible with X-rays. Due to the fact that neutrons have a magnetic moment and are scattered by magnetic atoms such as iron and chromium the scientist has another weapon in his research armoury. He is able, by their use, to find the position of magnetic atoms in ferromagnetic and antiferromagnetic crystals such as chromic oxide. Neutrons are also used in experiments where they are reflected, refracted and polarised.

These are some of the remote, highly technical uses

of research reactors. But what of the uses of research reactors which are nearer to everyday life, which will show a rapid return in betterment of living conditions for the immense expenditure already laid out?

Using research reactors, short-lived radio-active isotopes can be used for research in chemistry, nuclear physics, biology and medicine on the spot. In fact, often they have such short half-lives that they disappear before they can be transported very far from the main government reactors. Useful isotopes with half-lives of under a half hour include nitrogen-16, oxygen-19 and chlorine-38.

The future appears to hold one of two alternatives. Either industry will tend to build up around central reactors, or each branch of industry will construct its own reactor as a part of its normal plant. But these short-lived isotopes are by no means the only profit to come from nucleonics.

The ability of neutrons to make materials radio-active when they are absorbed is used in analysis and is sometimes more sensitive than spectroscopic or chemical methods. One part of arsenic in 7,000 millions of a diluent

can not only be detected, but can be measured by determining the amount of radiation it gives off after being cooked in a reactor. This is being used to control traces of impurities in the germanium used in transistors.

Chemical reactions are speeded up by using nuclear radiation from reactors. Gamma rays have been used to react ethylene with itself at very much lower temperatures and pressures than are normally used. This gives the plastic, polythene. Irradiated commercial polythene forms cross linkages between the polymer chains so that it becomes stronger and more resistant to heat and may be used in medicine after pressure steam sterilisation. Normal polythene would melt under this sort of treatment. Glycol may, in the future, be manufactured by irradiating methyl alcohol (wood alcohol). Phenol, useful in plastics, may be made from a mixture of benzene and water, and attempts have already been made at Harwell to make diamonds from graphite.

The radiation causes damage in solids, breaking chemical bonds and moving ions in the crystal lattices. It is possible that this may be used

in the future to manufacture transistors. It is clear that scientists are determined to use to the full any and every attribute of nuclear science, even if at first glance that particular attribute appears to be only destructive.

High-intensity gamma radiation sterilises food and drugs. Complete sterilisation requires several million roentgens and changes the flavour; but the keeping properties of food are improved by smaller doses that do not affect the flavour.

Nuclear reactors are used in biological research to accelerate genetic mutations for the development of plants resistant to disease. A current example is an oat, developed by the scientists at the Brookhaven reactor, which is resistant to rust. New moulds and new antibiotics are further useful items derived from the use of nuclear reactors.

A new method of treating cancer recently developed consists of injecting the patient with boron-10, which is selectively absorbed by the cancer tissue. This is then exposed to a beam of thermal neutrons from a reactor. The boron absorbs these thermal neutrons, becomes radio-active and emits alpha particles

which destroy the cancer cells. The beauty of the technique lies in the fact that the alpha particles have such a short range that they destroy the cancer cells, but do not penetrate into the healthy tissue. The killing radioactivity is actually generated in the cancer itself, and does its work there.

The principal types of research reactors and their locations are:

1. Natural uranium moderated by graphite. This was the first type built when heavy water and/or uranium-235 were not available, and it is unlikely that any more will be constructed. They use large quantities of uranium and pure graphite—the figures for Oak Ridge are: 35 tons of uranium and 500 tons of graphite.

Two in Chicago.

One at Oak Ridge.

Two at Harwell, U.K.
Called Gleep and Beepo.

One at Brookhaven.

2. Natural uranium moderated by heavy water. This type uses about 10 tons of uranium and 7 tons of heavy water. The core is a cylinder, about six feet in diameter and eight feet high.

One in Chicago.

One at Chalk River, Canada. Now in use again after the accident in 1952 that contaminated the whole area.

Two in France.

One in Norway.

One in Sweden.

One in Switzerland.

3. Water boiler reactors. These cost little—120,000 dollars—and are small, the core being a sphere a foot in diameter, containing $1\frac{3}{4}$ lbs. of uranium-235 as a solution of uranyl nitrate in water. They have a graphite reflector and are cooled by water. They must be leak tight, and are called boilers, although the solution need not boil.

Three in Los Alamos.

One in California.

One in North Carolina.

4. Enriched uranium solid fuel reactors. There are two types. The first is one in which the uranium is in sealed aluminium sandwiches to keep the fission products out of the open pool of ordinary water in which it is suspended. This is the least safe, as any damage to the fuel elements could spread the fission products. The core measures $1 \times 2 \times 1\frac{1}{2}$ ft. The second type uses a closed tank containing $7\frac{1}{2}$ tons of heavy water valued at a

million dollars and has a cylindrical core two feet in diameter and two feet high. It is not as efficient as other types.

Two at Oak Ridge.

One at Los Alamos.

One in Pennsylvania.

One in Michigan.

One in Idaho.

One in West Schenectady.

None of these types could explode like a bomb; but they could quite well spread radio-activity if they went out of control and overheated. The safest reactor is that using heavy water both as moderator and reflector.

High-intensity research reactors are used as pilot plants to test the materials for the larger power reactors.

The parts that must stand up to the intense radiation and keep their useful properties and perform their functions under tremendous strains include the structural metals, the gaskets, insulators and the materials in contact with the corrosive cooling fluids and reaction fuels.

Neutrons have no electric charge and can easily penetrate atomic nuclei at even low speeds. This makes them the ideal means of investigat-

ing the central problem of physics, the nature of matter and particularly that of the nucleus itself.

Truly we may look forward with confidence to a future wherein man has tamed the atomic fire, and has harnessed its energies to his own use. The great power houses and factories, using, consuming and eternally manufacturing atomic energy, are already in process of being built.

But alongside these great undertakings, the smaller research reactor will continue to be built, continue to pioneer new techniques and methods, and unravel even more of the mysteries of science.

It is now twenty-three years since the atom was first split in the Cavendish laboratories. In that short space of time much work has been done and many new discoveries have been made. But, for all the wonder of what has already been discovered, we know that we are but on the threshold of the future, that still to come are fresh wonders and undreamt of miracles.

The scientist, working with his research reactor, looks forward with complete confidence to that future.

Packing by Science

by *TREVOR HOLLOWAY*

PACKAGING IS A MATTER OF VITAL importance to almost every industry particularly when many of Britain's products are destined for the export markets. Comparatively few firms can afford the necessary time and money to conduct their own long-term research into packaging problems, but fortunately there is, at Leatherhead, Surrey, a highly efficient and well-equipped research centre ready and willing to investigate almost every conceivable packaging problem for firms large or small.

The Printing, Packaging and Allied Trades Research Association (hence the name PATRA) is one of the research associations which operate under the Department of Scientific and Industrial Research. Originally formed in 1931 to serve the printing trade (when it was known as PIRA) it became urgently necessary in the war years to add packaging to its research programme. The present laboratories, built at a cost of £110,000, were opened by H.R.H. The Duke of Gloucester to replace the old premises at Robin Hood Court, off Fleet Street, which were bombed in 1941.

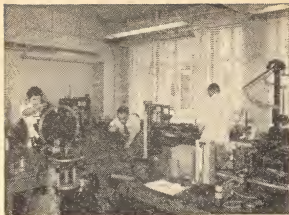
The Packaging Division has been humorously likened to a cross between a chamber of torture and a battle school for postmen! To a certain extent this is not a bad description, for at PATRA House parcels and packages are subjected to the rigours of transportation with specially-designed equipment. By means of weird and wonderful-looking apparatus, packages are given the type of handling they receive on an actual journey.

For instance, there is a huge contraption called the Drum Tester which reproduces light handling. It is a revolving metal drum about 7 feet in diameter, not unlike an old-time tread

mill, and is electrically driven. Inside the drum are a number of wooden baffles, all set at various angles. The package to be tested is placed within



SLING-TYPE DROP TEST



PAPER TESTING

and the drum set in motion. The angle of the baffles are such that the case or carton slithers from one baffle to the next as the drum rotates, falling heavily on its sides, corners and so on until usually it becomes very much the worse for wear.

After a while the package is taken out and meticulously examined to see how it has stood up to its ordeal and where, if any, its weak spots are. In other words, it is subjected to what may be termed a scientific post-mortem. The firm from which the package has come is then sent a detailed report by the Laboratory of its findings and recommendations.

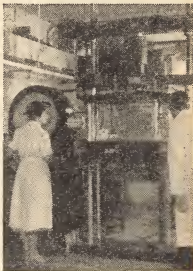
Then there are the Drop-Testers. One is a suspended sling arrangement fixed to a rope and pulley, the sling itself having a special quick-release attachment. Packages can be raised from 6 inches to 4 feet from the ground and then suddenly allowed to drop at various angles onto a bed of solid concrete. For purposes of the test the case may be filled with flour or sand of the same weight the case is expected to contain. The pack may survive—or there may be a crunching thud and up

may rise a cloud of flour.

The other Drop-Tester, an altogether bigger job, is affectionately referred to by the staff at PATRA House as the "Hangman's Drop." This is designed to test heavier and bulkier packages up to 500 lbs. or so. The containers are placed on dividing trap doors above floor level, a catch is released and down crashes the container to its fate. As with the

Drum Test, a post-mortem is held and, with as much care as a man from the

COMPRESSION TEST, simulates effects of stacking



C.I.D., an official takes down the particulars of the "casualty," noting where it failed and why.

Yet another ordeal in store for packages sent to Leatherhead for testing is the Inclined Plane Impact Test. The sound of noisy crashes will lead one to a device which is in the nature of a 25-ft. incline down which travels a flat trolley at a maximum speed of 8 m.p.h. A package is placed on the trolley at the top of the incline and the trolley is then sent headlong down the slope to crash into a solidly-constructed wooden buffer.

The effect on the package is much the same as would befall it aboard a carelessly shunted goods train.

It is, indeed, a curious kind of laboratory we have described so far. Instead of the conventional quiet and orderliness most of us associate with a research centre, here we encounter what at first seems chaos. It is nothing of the sort, of course, but it represents science at work on very important research under conditions (for the packages) which prevail during transportation by road, rail or sea.

But not all the Packaging Division is concerned with these knock-about tests, for there are other and subtler methods of putting a package (or packaging materials) on trial.

Goods for despatch to tropical regions often need to be guarded against attacks from destructive insects. Packages in warehouses or in transit may be attacked by various

moulds, or be exposed to petrol or gas fumes; it is also necessary in many cases to guard against grease or damp penetration. All these factors can affect not only the strength of the packaging materials, but also the contents of the packages themselves. Cheese, butter, fats and other food-stuffs may be ruined after the container has been contaminated from the outside. Extremes of heat or cold have also to be reckoned with.

PATRA House scientists have studied all these problems. Sections of



BIOLOGICAL LAB—mould and pests

the Laboratory coming under the heading of mycology, entomology and microscopy are a strange contrast to the more boisterous research conducted in the basement of the building.

Numerous types of British and foreign insects are bred and their habits and appetites closely studied. In this way the scientist, by allowing the insects to attack various packaging materials, can ascertain which materials are most vulnerable as well as experi-

ment on the best types of deterrent and how to apply them.

The common cockroach is a notorious attacker of packaging substances, and if ever you pay a visit to the laboratory you will probably be shown an English specimen of formidable appearance, preserved in a jar and affectionately referred to by the staff as "Henry." There are also many other jars containing a great variety of live insects.

Moulds are microscopic plants, and by their growth they can stain the materials on which they live, or cause an objectionable musty odour which eventually taints the contents of a package. A wide range of moulds is, therefore, cultivated at the Laboratory and introduced to packaging materials so that their action, likes and dislikes, may be constantly studied. From such observations the scientist gains data for seeking methods of checking growth either by chemical means or by establishing what materials are naturally most mould-resisting. Few people realise what a vast range of different moulds exist. The Laboratory has no less than 25 large volumes cataloguing moulds which have been identified during the past seventy years or so.

In special "ovens" the size of a small room, packages are stored under tropical, temperate or Arctic conditions and constant temperature and humidity maintained. If a firm wants to know what the effect the climate of Central Africa will have on their packages, PATRA can give them a very good idea. One problem met with in tropical climates is that labels frequently come unstuck—a matter of no small concern especially where foodstuffs or medicinal products are

involved. As a result of long-term research, the Laboratory can give valuable advice on ways of overcoming this problem.

The Laboratories rank among the finest in the world and are said to surpass in efficiency even the best in America, a country which has long had the reputation of being "package conscious."

Actually there are two angles on this perfect package business. A pack may be sub-standard and not man enough for its job; or, on the other hand, a firm may be using a package which is far and away too efficient for its purpose, thereby wasting a considerable sum of money each year.

"Let's get in touch with PATRA," British businessmen are saying in ever-increasing numbers. "They'll solve the problem for us." And with the aid of Henry's relations in the insect "farm," the various gadgets in the "chamber of torture," etc., coupled with infinite patience and skill, the staff at the Leatherhead research centre seldom have to admit defeat.

AIRBORNE TELEVISION

Continued from page 16

cowl and entry guide vanes, which accounts for the complete success of the test programme.

Further anti-icing tests are being carried out with another Proteus power plant, which embodies a number of production refinements, including an increase in the amount of heat available for anti-icing purposes in the region of the entry guide vanes.

British Government scientists are—

Making Rain to Order

BY JAMES E. CARVER

EXPERIMENTS IN RAIN-making—the first official ones of their kind in this country—are being made in the Salisbury Plain area by Air Ministry scientists. Such experiments have been carried out in many countries, among them the United States, France, Russia, India, Pakistan, and various parts of Africa, and in Australia.

Methods used vary. The one on trial here consists in burning a solution of silver iodide. The crystals diffuse through the atmosphere, the wind blows them into the clouds, and they combine with minute drops of water to freeze and then grow bigger, falling as raindrops.

The rain will not fall in the Salisbury Plain area where the crystals are released. They may be blown miles away, and the scientists have to calculate where they have reached. By

comparing rainfall figures in such areas, before and after the experiment, they hope to discover whether the precipitation has been increased.

Silver iodide was used in the first big official trial in the United States. The Government put up the money and the General Electric Company carried out the researches under Dr. Langmuir. One downpour was estimated to have precipitated three hundred and twenty thousand million gallons of water, and others were reported to be successful, too.

In fact, a strange thing happened a couple of years back, when the election slogan of a Michigan politician became: "No rain on Sundays." He was complaining that wet week-ends in Michigan were caused by the Government's practice, earlier in the week, of doctoring the clouds

in New Mexico to produce artificial rain. These clouds were being driven by prevailing winds as far N.E. as Michigan—at least, the politician so alleged.

With regard to such experiments, it ought to be made plain that all reputable scientists agree that there is no likelihood of large-scale effects. Among outside observers there has been a tendency to draw spectacular conclusions on the basis of too few observations and without adequate control experiments. The important questions arising out of cloud seeding (the correct term for dissemination from the ground or dropping from above by planes) are: how much rain could be released which would not have fallen naturally; and whether the time of release, and hence its distribution, could be altered. It seems very unlikely that the rainfall pattern over very large areas can be affected.

Despite these limitations, in the United States “rain-making,” “controlled rain-

fall,” “weather making,” “weather to order”—or what you will—has become quite a commercial proposition, since the Federal and State Governments will not undertake the job on a speculative basis. There are at least four major concerns of the kind, one bearing the typical American title of the “Water Resources Development Corporation.” “Controlled rain making” is a growing, if young, industry. It is made use of by banks, estate owners, railways, power companies, aviation concerns and other industries such as chemical, paper, and textile mills.

Dr. E. G. Bowen, who has charge of research into rain-making in Australia, is more optimistic than many scientists as to its possibilities. Nobody can put clouds into the sky, but he believes that, given the clouds, in some parts of the continent rainfall could be increased up to 50 per cent. So far most tests have been carried out in the Sydney area, where falls have ranged

from a quarter to three-quarters of an inch, in showers lasting from 40 to 60 minutes.

Increased rainfall would make possible a change from grazing to cultivation in many districts. The most difficult problem to be solved is that of cost, and Dr. Bowen thinks the answer will come within five years. When it is found, he says it will be possible to increase the rainfall on the inland fringe of the south-western corner of Western Australia; the time of arrival of the monsoon rains in Northern Australia could be stabilised, as at present monsoon clouds often hang in the sky for long periods because there are no salt particles in the air to turn them into rain; and some types of drought may be broken.

There is probably no danger of rain makers exhausting the potential supply of rain on the Earth, because only about one per cent. of the total moisture in the atmosphere falls natur-

ally as rain. On the other hand, merely bringing the rain down is perhaps the simplest job. Other things have to be taken into consideration. In the Orange Free State some farmers talked about suing the Government because rain brought down artificially damaged their crops, as it came down in the wrong place. And in France another downpour, instead of falling where it was most needed, nearly caused a flood in the Rhone valley some miles away.

For such reasons as this, responsible scientists in this country have insisted that any experiments designed to alter the intensity or distribution of rainfall here should be conducted in a scientific and responsible manner. In order to co-ordinate the requirements of farmers, water engineers, and other interested bodies, and to deal with possible legal difficulties, it is essential that the work should be done under Government auspices.

PART TWO

Desirable Residence 1995

BY 'TRIONA LAW

WOULD YOU LIKE THE television on while we have a cup of tea or shall I just show you what we've had installed . . . ? Oh, yes, there is the TV, but you'd never recognise it as it's got a cover that fits flush with all the other cupboards. It's the one in the corner over the sink. Nearly everything's operated from my desk here—I call it my control desk. All the buttons on the board at the back are for switching things on and off . . . if you look you'll see the fridges are all on—green buttons pushed in. I swing this wire guard over if anyone brings any children to the house, but the buttons do need a fairly strong push, so I don't think they'd manage to change them. But just in case, anyway . . . after all, who wants

the fridges defrosted before the goods are out of them!

You know, sometimes I can't help thinking how lucky we are without having to pay such high prices for our electricity now all the stations are atomic. Why, if I had to run a house in the old style I'd be broke within a year with all the gadgets I've got.

What do you think of our sockets for the gadgets, too? Look, the grooved board running round the walls just above the workspace. When I want to use a mixer or a percolator, I just slide one socket along the board—they run in the grooves—and plug in. There's about half-a-dozen down there at the end of the worktop and when I'm getting breakfast ready, believe me, I'm glad of every one of them . . . what with toast,

and coffee, and the frying pan and mixer, and heaven-knows-what-else to plug in all at once. John said there's a wire in each groove so that there's a connection all the way along the board, but it doesn't sound very safe to me. He *says* it's all right, though, so I suppose he knows . . .

I'll tell you what—pour yourself another cup of tea and give me one, too, and I'll go round opening cupboards and showing you what's inside while you take it easy . . . Of course it's still hot; the teapot's got an element in it with a thermostat that keeps it just below boiling point—I do hate cold tea.

Now, first there's this cupboard under the work table with all my mixing bowls in it. I also keep the flour and all the things necessary for pastry-making and things like that in it. The wall cupboard above the workspace contains most of my dry goods, and this one next to it the big gadgets, my toaster and mixer, and the pressure cooker. This one, next to it, is the meat refrigerator, but the fish is in there, too; in fact I keep all the food for the meat dishes ready in there, so I can just

put them straight into the oven. That's directly below it, and I'm so pleased that it's one of those waist-high jobs. I don't have to bend at all. The door drops down and I can stand the pans on it. Here are the hot-plates below it, and below that the cupboard with all the saucepans and casseroles in. Then at the corner the space is just filled in.

Now the TV, above the sinks, and a small cupboard next to that with washing-up powders and soaps in it. Under the first sink I've got a swing-out dish-washer and under the second one a rubbish grinder. How people could have used such filthy, smelly things as dustbins I just can't imagine—and all those dreadful *flies* . . .

Well, of course, I want two sinks! If I'm peeling potatoes I want one to put the peeled ones in, and one to do the peeling, and the same applies for all the other vegetables that need preparing. There they are, in the cupboard next to the disposer . . . I just pull it out and the vegetables are in racks fitted to the door. They don't look very strong but each one holds about ten or twelve pounds.

Above the work top, on the vegetable cupboard, I've got a refrigerator for the prepared vegetables, salad-stuff and fruit, and I keep all the dairy produce and drinks in there, too. And next to that is the deep-freeze for packet stuff, both what I buy and what I make up myself. Underneath is the big freeze unit for quick-freezing my own packages, and then the outside wall finishes that lot.

I liked the idea of having the oven on the inner wall and all the rest of the freezers and sinks along the wall between the laundry and the kitchen, because it saves an awful lot of running about between one cupboard and another.

I didn't have a separate table because, with all that work surface on top of the cupboards at the same level, I've got plenty of room to operate. So I just had the desk and chairs. That box at the right hand side of the desk is the telephone and also the microphone through to the other rooms in the house, and with that vision screen above it I can see what room John's in before I switch on to speak to him. How d'you like the dialling system? That row of keys . . . just the same

as the dial, of course, except that it's quicker, as you don't have to wait for the dial to turn back once you've dialled. Same letters and figures on each key, as was in the holes on the dial. And behind that gold gauze is both the speaking and hearing microphone, so I have both my hands free in case I'm busy doing something else.

That section with the pull-out slides at the right side of the knee-hole is my recipe catalogue. It works on the old office filing system, with each tray having a lot of flaps on it, and each flap having one recipe with only its name showing. I just run my fingers down the names till I find the one I want. Have you finished your tea? . . . Good, let's go and look at the other rooms now.

Laundry first. Another sink, of course, but I only use that for soaking really dirty washing before it goes in the washer. I don't need it for rinsing because the machine does all that for me. I did think of having one that worked with sound, but decided I didn't like the idea and had the ordinary pulsator kind. It's fully automatic, washes 'em, heats the water,

adds the soap, rinses, and even half-dries them, but I've got a proper drier next to it which finishes them off so that they're just right for ironing. Here's the iron, next to the drier, rotary, of course... but I also have an ordinary iron for the little fiddly bits that I can't manage on the rotary.

We did think of putting TV in here, but as I usually go back and do some cooking while the wash is being done, we didn't bother... I can get a whole dinner prepared while the washing is done... after all, it takes half an hour, and I can do a lot in that time. Here's the airing cupboard, at the end of the row—lovely and big, isn't it? I put the ironing straight in as soon as I've finished it.

Now, here's the spare room, empty at the moment... and this is John's room. He's got a workbench all fixed up with a small power tool and does absolutely everything with it. There are dozens of gadgets he fits on to it and if I needed to polish floors, I could use it, too. But of course with the foam floor on top of the concrete I don't need a polisher, which is a blessing... That's his desk the other side

of the room, and the typewriter is inside a well in the middle of it. You press a button and it comes up, and press it again and it makes a flat-top desk, just like you see it now. The screen on the left-hand side of the desk is his viewer for all his transparencies and photos, enlarges them beautifully. There's a whole row of buttons for selecting the right ones down here, but I don't know which is which, so I'd better not try pressing them.

The bookcase behind the desk has the TV screen and radio in the middle, and next to that is the gramophone and recorder, and all his records are kept in these cupboards below them. John's like all men, he doesn't like me tidying up in here, so I just leave everything alone for him to see to.

Now, here's the bathroom. Do you like the pink and green colour scheme? I just couldn't resist it... gives it an under-sea look. Bath, shower, drying-vent—blows warm with this button and hot with that one—it's just grand for drying my hair, and it only takes half an hour, even if I set it first. If I don't, then it's only a ten-minute job. Then the

wash basin, the lavatory and the bidet. We thought we'd just have the one big room with the washing space and the lavatory in one, since we had lavatories in all the bedrooms as well, otherwise we might have had that separated from the main bathroom. Now let's go back and see the rest of the other globe. You saw the dining room and living room as we came through, and here's the bedroom. This one is John's and mine . . . the guest room is the same except for the colour scheme. We thought we'd have twin beds so that if either of us was ill, we could just slide them apart, but normally we keep them made up as a double bed. The two foam mattresses zip together, and there's a foam overlay so that the zip doesn't rub the bedclothes.

Not that we use many bedclothes . . . we don't need to with the central heating, but there are a couple of sheets and an electric blanket, just in case it gets too cold in winter. Besides, I had to have a blanket—a sheet isn't heavy enough for me—I like to feel that I've got bedclothes over me. The pillows are

more foam. And look at our carpets . . . wouldn't you just swear they were real sheepskin? They're not, though, only plastic, but that makes them so much easier to keep clean.

The bedheads hold more books and a radio, and the bedside lights. And there are more lights built into the top of the wardrobes and the sides of the dressing table mirrors. They can be switched on from the bed or the door—see the switch in the girder where I've pulled the wall back? The dressing table and wardrobes are built along the wall between us, and the guest room and the guest's cupboards and dressing table also back onto that wall. These are the lavatories at the end . . . the doors match up to the furniture so, unless you knew you'd think it was another wardrobe. Basin in the corner, there, and the drying vent above it . . . foot operated this time, with that little knob on the floor.

Now come and see the guest room, and tell me how soon you'll come and spend a night or two with us . . .

STAR MANIA

BY ALEX MORRISON

JOHN BAXTER STOOD AT THE END OF his garden, staring up at the warm velvet sky.

It was a clear summer evening. The scent of the rose bushes was thick in the air and from somewhere along the row of neat, semi-detached houses, a radiogram offered a background of soft, sentimental music.

It was a perfect night, but John saw none of it. His mind was a hundred million light years away, sliding across space, among the stars.

The restlessness was in him. That same nagging germ that centuries before had sent men searching across the oceans in tiny wooden ships. Then, when metal monsters had made the oceans small it had forced them up into the clouds in flimsy craft of wire and canvas.

And now, more insistent than ever, perhaps because it was nearing the end, it was drawing them up, towards the stars. John stared, hypnotised. In his lifetime they had reached the moon, the first step to infinity. But as yet only a few could go.

A door opened and a shaft of light splashed across the lawn. Betty's voice came through the still air. "John, are you coming in to dinner?"

He heard nothing.

The voice was nearer and more insistent. It touched the fringe of his consciousness. He frowned.

Betty slipped her hand through his arm and he allowed himself to be led gently towards the house. Gradually he felt reality flooding back to him.

He stopped on the back porch, clinging to his dream. He pointed to a tiny speck of light shining steadily above the horizon. "There she is, Betty," he said softly. "Venus. God, what would I give to be going with them tonight."

Betty tried hard to understand, but she was hurt. "I don't know, John," she said. "What exactly would you give?"

He looked at her and then dropped his eyes. For a moment the spell of the stars was broken.

Inside the house he felt better. This was his own little world with familiar things. He cheered up and became alive again. He complimented Betty on the dinner and joked with her. He was more like his old self, before the sickness got him.

"Is that a new dress?" he asked. "Well, it certainly suits you. Why is it you have to keep reminding me of what a pretty wife I have?"

She smiled happily.

"That reminds me," he went on, "I picked up something today." He pulled a small box from his pocket.

"John!" she said, delighted. "Earrings. You shouldn't have!"

"I found them on a 'bus," he said, and they both laughed.

She hurried over to a mirror to try them on while he switched on the television.

"Mustn't miss the send-off," he said.

She felt a little catch of fear as the picture materialised on the screen.



The voice of the commentator came fast and excited.

—of millions of people here tonight to watch the beginning of the greatest enterprise since time began. In exactly thirty minutes the rocketship Discovery, that gleaming monster that you can just see in the centre of the picture, will blast off on the 26 million mile journey to Venus. The eyes of the world, perhaps the eyes of the whole universe, are on these men tonight. We must be truly proud of them as, in this man-made rocket, they pit their skill against the stars. What man wouldn't give his right arm, both arms, to be going with them tonight? Out there, blazing a trail as bright as a shooting star? Feel humble, ladies and gentlemen, as you sit in your homes, because history is being made tonight!

Betty sat at her husband's feet, her head on his lap. She felt him become tense as the close-ups of the crew appeared on the screen. She felt again his terrible disappointment when he had been rejected for space crew.

"Look at them," he said bitterly. "Ambassadors of humanity, grinning like apes. How many of them deserve to go?"

The telecast ended with a view of the giant rocket leaping upwards on a ball of orange flame. John switched off the set and stared moodily at the empty screen; then, the explosion still burning in his eyes, he stood up and began to move about the room, nervous and edgy.

"Why should they go?" he asked. "Why them and not me?"

"Your turn might come," said Betty, soothingly. "Anyway, it isn't the end of the world."

"It should be," he said bitterly. "It

might just as well be, for me. All that work. All those hours of studying. For what? Nothing! Doomed to stay on this rotten planet for the rest of my life! Struggling to earn a living, mixing in with all the corruption and petty systems. Man was destined for greater things than that. What is there left to achieve here, anyway?" His voice rose. "Everything was done a hundred years ago. What is there besides getting married, having kids and getting old?"

Betty choked back a reply. He caught her arm and dragged her to the window. "See that up there? It's something worth fighting against. A challenge to a man. It's clean and untouched."

He could feel the band of frustration tightening round his head. He gripped her arm tighter. "If I could reach one of those places and look out where no man had been before, then I'd willingly die in that same instant."

Betty pulled herself away. She had known that tonight would be a crisis with John and she had prepared for it. But now, in the light of his mood her efforts seemed pitiful.

"I thought we might like to see a show tonight," she said desperately. "I've got the tickets."

John peered out of the window, quiet now, after his outburst. "Think I'll take a walk," he said.

"I'll come with you," she said eagerly. "Just wait a moment while I get the tickets."

She watched him uncertainly for a moment, then she ran from the room. When she returned he was striding down the garden. She knew that it was no use now. He would stand there staring until daylight wiped that last star from the sky.

In a field beyond him stood a giant electric pylon. A mesh of girders, pointing like a finger towards the sky.

She followed the direction and looked up at the clusters of cold bright stars. They looked back down at her across that vast emptiness, and for an instant she caught a glimpse of that strange power that tore men out of their homes and drew them up into the frozen darkness.

She shuddered and went back into the house, wondering what one woman could do against the whole power of the universe.

Betty woke suddenly in the night, convinced that something was wrong. She reached out to wake her husband and remembered that he had not come to bed. Gripped with sudden panic, she ran down into the garden calling his name. There was no sign of him. Distractedly, she set off towards the town. Then something made her stop and look up. She saw a tiny figure climbing towards the top of the pylon.

"John!" she screamed. "John! For heaven's sake!"

He climbed on, hearing nothing. Above him the stars shone, clear and steady, drawing him up. His breathing was laboured with exertion as he pulled himself slowly over the steel girders.

The germ had taken control, the tight band had gone from his head. He felt free for the first time in his life. With each effort the stars seemed nearer. Through a swirling mist he saw them and he felt strangely elated, confident that he was achieving his destiny. He reached the wires at the top and Betty saw a brilliant blue flash. She saw his body spin out in the darkness, crash into a tree and hit the ground in a flurry of broken branches.

She found him lying twisted and burnt, yet when she lifted his head he was smiling. The tree had broken his fall and prolonged his life for perhaps half a minute. He used the time to say:

"Betty, I did it. I touched the stars."

THE SUPER SPRITE—continued from page 7

The attachment and jettisoning arrangements vary for different aircraft installations, but in the interests of the aircraft performance the nacelle takes with it all attachments and bracings, though leaving the release mechanism, or part of it, in the aircraft. Several types of release mechanism can be employed and nearly all of them combine with some sort of thrust or shear-taking device for the actual engine thrust loads. Hydraulic, pneumatic or electrically operated latch-pins can be employed or, alternatively, an electric bomb-type release or explosive-bolt attachment, all types, of course, being operated from the pilot's cockpit.

The Super Sprite can in no way be regarded as a semi-expendable unit, although it may be jettisoned after every take-off. Initially the overhaul period is fixed at 50 firings but this

period will be extended in the normal way as experience is built up. During overhaul small components such as rubber seals and valve seats, and possibly the flame tube, will need to be replaced; the catalyst pack may also have to be changed although it is expected to last appreciably longer. Subject to periodic overhauls the ultimate service life of the Super Sprite may well exceed the equivalent life of a more conventional engine.

In the Super Sprite de Havilland offer a simple, safe and reliable rocket engine for assisted-take-off use which employs propellents that are easy to handle and readily available. If the present trend towards increased size and wing loadings of aircraft, both military and civil, continues, it could well be that in the future such units will of necessity be included as one of the fundamentals of the design.

The Lady and the Bull

by J. T. McIntosh

THEY WERE LAND-
ing in the middle of a
beautiful city, though a
dead city. But no one was
impressed. Beautiful cities were
ten a penny in the civilisation
ruled by Centre. And beautiful
dead cities were a hundred
a penny. What use were dead
cities to anybody?

They took it for granted
that Mellice, the city below,
would be in first-class con-
dition, though it was forty
years since anyone had lived
there. The foundations of the
city would have been sterilised
so that not for hundreds of
years would anything grow
in that soil. The stone, wood,
glass and plastic of the build-
ings would be coated with
SLX, still keeping the whole

city free of insects, bacterial
or fungoid growths. The one
power circuit which would
have been left running was
the SO relay, the alarm
circuit which saw to it that
any animal but man which
blundered into the city would
be given increasingly heavy
shocks until it retreated or
died. SO, appropriately, stood
for Stay Out.

These three things would
have kept Mellice, like a
hundred thousand other
derelict townships spread
through the galaxy, in good
shape against the time when
mankind, instead of retreating,
began to advance again. Some
of these derelict cities might
be needed again.

"Why did you pick

Mellice?" Eric asked. He was naturally sociable, despite his jealousies and resentments, and it had proved quite impossible for him to treat Farley continuously as an enemy, though he conscientiously snapped at him when he remembered to do so.

"It's the fourth city," said Farley, with audible satisfaction.

"Well?" pursued Eric.

"There'll be a search for us—of course there will. Particularly on worlds such as this. There will certainly be a ship visiting Undrene. But where will it go? Martinburg, Windsor, maybe Jonus City. Not Mellice."

"I hope you're wrong," Lady Hilda sighed, "but I'm afraid you're right."

They were, after all, not very important. Lady Hilda herself was both a noble and an Administrator, a very high and mighty person—but not one of the first ten people in Cosmopolis, nor the first hundred, nor the first thousand. One of the first ten

thousand, perhaps—well on in the nine thousand nine hundreds. There would be a search, true, both on her own account and because of the strange circumstances of her disappearance. It would be a big and expensive search, as searches went.

But it would be spread thinly. A ship would visit Undrene and land at Martinburg, which had been the principal city. Possibly it would also make a brief check at Windsor and Jonus City. Farley had guessed right, Hilda reflected. She wasn't important enough for the search to be extended beyond the first three cities of the derelict worlds.

Farley let Nila do most of the work of landing the ship. He stood on one side of her, Eric on the other, and Nila loved it.

"You're doing it better than I would," Farley admitted.

Nila laughed delightedly and turned challengingly to

Eric. "Better than you, too, Eric?" she demanded.

He stiffened and said: "How do I know how I'd handle this scout? All ships are different."

Nila put the scout down without a jar. And as she did so, Eric turned, drawing a heavy spanner from his sleeve.

"All right, back against that wall, Farley," he said triumphantly. "You, too, Nila. We don't trust you too far."

Farley didn't move. "Don't be a fool, Eric," he said.

"Back against the wall, I tell you. The automatic control is now off. I waited till——"

Lady Hilda had been watching Farley, and knew already that Eric was wasting his time. She stopped him with a gesture and looked expectantly at Farley.

"Thank you, Lady Hilda," said Farley, with deliberate politeness. "I see you give me credit for *some* brains. Instead of explaining, Eric, I suggest you try to take off again."

It took Eric only a few seconds to find that the engines were dead. Apparently Farley had set the controls to cut out permanently after landing.

"The situation hasn't changed," he told them. "You can't take this ship anywhere I don't want it to go, unless you can dismantle and modify the controls. And if you try, we're all liable to be stuck here for ever."

"You're crazy!" Eric blazed at him.

"You keep saying that," Farley said indifferently. He was beginning to lose any sense of inferiority he had ever felt in Eric's presence. Eric wasn't like Lady Hilda. Farley felt himself more than equal to Eric in any circumstances except smart social occasions, which Farley would be careful never to attend anyway if he could help it. "So far, crazy or not, I seem to have had things all my own way."

But as he said that, complacently, he felt Lady Hilda's

cool, shrewd gaze on him, and the complacency went out of him. Equal to handling Eric he might be, but he would never be equal to handling Lady Hilda and he knew it.

He tried to diminish her in his mind, by telling himself she hadn't been able to accomplish anything against him so far. He pictured her dazed, breathless and dishevelled as she had been after her encounter with Nila, reminding herself that she was fallible, conquerable and only human, after all.

He tried—and failed. He still found himself placing Lady Hilda on a level higher than his own. He didn't allow himself to fear her, but he couldn't regard himself as her equal.

At the end of a week even Eric had stopped saying Farley was mad. The method in Farley's madness, both at the Undrene end and at the Camisac end, emerged bit by bit.

First of all, it soon became clear that he had them prisoners without hope of escape. Mellice was a dead city. Far underneath them, a few motors still turned, keeping the SO relay active now and for the next few thousand years. A gang of technicians could probably have set the huge generators going again in a matter of hours, supplying atomic and sun power to light and heat the city, operate the moving ways, elevators and escalators, mobilise the trucks, trolleys, railcars, streetcars, planes, helicopters and subways, bring the dead city back to life.

"But what can *we* do?" Farley taunted Eric, as they explored together—together because the big, brilliant, empty city was frightening if one was alone, and all four of them admitted it. "What can we do but look for a switch marked On-Off? Unless we find something like that, we're helpless. Isn't that so, Eric?"

Eric remained glumly silent,

for it was true. They all at one time or another wandered round the bare, silent power stations with the optimistic idea that the purpose of all this tidy, impressive-looking machinery would suddenly become clear and they would be able to set the wheels turning again.

However, what Farley said was inescapable. The height of their ability in that respect was the ability to flick a switch. If there was no switch that simply turned on the power, the power would have to remain off.

And with no power, no mains supply, every machine in the city was useless. No vehicle, elevator, light, weapon, cooker or radio would work.

That meant they were prisoners. For between Mellice and Martinburg lay two thousand seven hundred miles of forest, teeming with quite unusually dangerous animal life.

Undrene had once been a sportsman's world. Its gravity

was only two-thirds Standard, which gave hunters from bigger worlds an apparent advantage. They needed it, however, to offset the ferocity, variety and weight of numbers of the opposition.

It was a warm world, a fertile world, a friendly world in every respect save for the downright unfriendliness of its fauna.

"I could get through to Martinburg," said Farley without boastfulness. "But none of the rest of you could."

"I could, too," said Nila.

"Maybe. I doubt it. You're tough, Nila, but Undrene in the raw is tougher. No, you're prisoners, all of you, and you might as well get used to the idea."

There was no doubt about it, Farley was a bad winner. He couldn't help gloating over the helplessness of Lady Hilda and Eric. Once he so far forgot himself as to do it with Lady Hilda when they were alone, when he was obviously gloating over her and no one else.

They were in one of the power stations, a thing of big, smooth, metal casings and no visible machinery. Farley waved his arm and growled his triumph.

"Look at it—enough power to shift a world, and we can't even get a spark out of it. Isn't civilisation wonderful?"

"That's no argument," retorted Lady Hilda drily. "None of us is a doctor, either, but that doesn't prove there's no such thing as medical science in our culture."

"I'm not arguing," said Farley, still gloating. "I'm just saying—look at us. Waited on hand and foot by machines we don't understand. Helpless when they won't go. Isn't there something to be said for pioneers, after all?"

Hilda laughed. "Why stop at the pioneers?" she mocked. "Or at Adam and Eve, for that matter? The logical conclusion of your argument is that the best form of life was the amœba, which never meddled with anything it

didn't understand, never built a city like this, and certainly never forgot how to keep it going."

Farley sobered, reddened, took a step towards her and controlled himself with an effort. "Now, look here, Lady Hilda," he said defensively. "I know better than to try to argue with you. But the fact that you can beat me in any argument doesn't mean I'm always wrong."

Hilda's sense of fairness made her admit that. "Even you couldn't always be wrong," she agreed.

"And what I'm trying to make you see," Farley pursued doggedly, "is that this isn't right. The four of us, three important people and a girl who's nobody, in a city just bursting with possibilities and strength, and the only one of us who has any hope of doing anything about it is the girl who's nobody."

"Nila?" Hilda exclaimed, surprised. "What, is she a technician?"

"No, but she could be. Given long enough, caring enough about it, she could set this city going. Because she can see how things work. We can't. We're . . ."

He shook his head and gave up, knowing he wasn't putting into words the vague but strongly-held conviction in his mind.

Lady Hilda frowned at him. Just for a moment he had almost seemed to make sense. But, after all, though Farley obviously wasn't capable of seeing it, her first counter-argument was the complete answer to any point he tried to make along those lines. They hadn't a doctor with them, but that didn't mean the civilisation which Centre controlled was primitive medically. And the fact that they couldn't set the generators rolling meant only that they didn't have a technician with them.

Lady Hilda was also beginning to guess Farley's real purpose in bringing them to Undrene. Nila dropped a

hint of it, and without saying anything to make Farley suspicious, Hilda collected a few unsuspecting answers from him which were all she needed.

It was easy enough to guess that Farley had been engaged in embezzlement, but what he hoped to gain by kidnapping her and Eric and taking them to Undrene took longer to work out. Gradually, however, Lady Hilda got the picture.

Wyger, the Deputy Premier, must have been involved in the embezzlement. At any rate, Farley had left him in charge, and the obvious purpose was that Wyger should clear things up. Given two years—yes, he could probably do it. That part of Farley's plan was sound, too. Camisac would be investigated again in two years' time, and as a result of Wyger's clerical revision the position would be different. Camisac would not be evacuated.

"But what good will that do Farley?" Eric asked, as he and Hilda discussed the

matter. "It still doesn't make sense."

"No," Hilda agreed, "but I wonder. A thing looks silly, and then you find a reason for it. Another reason. Then another. Is Farley capable of having found a complete answer?"

"No," said Eric decidedly. "Bulls don't have brains."

"I wonder," said Hilda again. "We underestimated him, you know, Eric. Don't let's keep on underestimating him. There's much more to him than there appears to be."

"Yes—as well as all the rest he's a thief, a criminal!" Eric exclaimed.

Hilda shrugged. "Oh, that's a detail. Most of us are as dishonest as we can safely be. Ever since taxes were invented, people who regarded themselves as honest have been lying and cheating and bluffing their way out of paying them. You've done it, Eric. So have I. And that's all Farley has done—evaded a tax, in effect, on a big scale."

"I never thought you'd defend him, Hilda!" Eric said, outraged.

"Nonsense," said Hilda acidly. "I've been defending him since we first met him—against all the unreasonable attacks you've made on him. Try to be sensible, Eric. Do you realise what he could have done, if he were really just out for all he could get?"

Eric frowned and shook his head.

"He could have taken a fortune from Camisac, legally, by letting us evacuate the place, illegally any time he liked, and bought himself into a position, somewhere in the system, a thousand times better than the one he's in now, trying to save Camisac."

She saw she'd left Eric far behind. She reviewed her own conclusions, realised without conceit how much imagination and intelligence she'd needed to form them, and decided not to try to get Eric to agree with them.

"Oh well, never mind," she said lightly. "Still not considering marrying Nila, Eric?"

Eric started almost guiltily.

"Oh, you are, now," Hilda murmured, nodding.

"Well, damnit, I'm not made of wood. And if we really are going to be here for years——"

"You don't have to make excuses. Marry her if you like."

Eric stared at her. "I thought——"

"You thought I'd object? It's you who have been prejudiced all along against Camisac and anyone belonging to it, Eric, not me. If I were you, I'd marry Nila and be guided by her for the rest of my life."

Eric frowned. "I'm being pushed into this, first by Farley and then by you. Each of you with your own purposes. You've got a scheme of your own in this, Hilda, don't deny it."

Hilda smiled. "I won't. But remember, Eric—it's up to you. Nobody can make you marry Nila. Make up your

own mind. I'm going to fix dinner."

She left Eric and made her way to the scout. Though they were sleeping in Mellice, to all intents and purposes they were still living on board the scout. Mellice could supply them with beautiful rooms without light or heat, magnificent cookers which would not cook, faucets which turned but supplied no water, and huge stores which were completely empty. Their food and drink had to come from the ship, and if they should ever be cold, which wasn't likely to happen often in Undrene climate, they would have to go to the scout for comfort. Only there could they wash, too. Mellice's water supply, like everything else, was off.

The canning of food had reached perfection centuries before, perfection meaning that eating from tins was in no way inferior to dining in a hotel restaurant. It also meant that the preparation of food from tins had to be

foolproof. All Hilda had to do was decide on a menu, find the required cans, work out from the labels exactly when to trip the heating switches so that everything would be ready precisely when it was wanted, set the table and wait for the others.

While she did so she was pondering over what she had said to Eric about Farley. To Eric it was simple—if you disliked a person, you thought the worst of him all along the line. Hilda had a different attitude—the more reason you had to be unfair to a man, the more careful you had to be to do him strict justice. She knew there was a third, higher, point of view—some people couldn't help being just, whether they loved or hated the people concerned.

If her ideas about Farley were correct—and she was sure they were—he wasn't fighting entirely for himself. He was trying to right a wrong he had done, working for Camisac, seventeen million people—and, true, for

himself as well. Risking a lot, and not hoping to gain much. Not for himself.

It was difficult to regard him as an out-and-out scoundrel, even if he did disorganise her life for two years.

Farley was reading, Eric staring moodily across the city and Lady Hilda bringing up to date the diary she had been keeping since the ship landed at Mellice. They were in the vast sun-lounge of the hotel they had appropriated.

Nila burst in, and at once they were all staring at her. Her air of triumph would have been enough, without the unusualness of her dress. She wore dirty grey slacks and an old white shirt which was smeared with oil. There was oil on her face and hands, too. Clearly, Nila had been working.

"All right," she said gleefully. "Now *I'm* boss, and you can all do what you like, provided it's exactly as I tell you."

"What have you done, Nila—made a time-bomb?" inquired Lady Hilda drily.

"No. I've been working on the ship. Now it's *really* disabled. Nobody but me can put it right. And that goes for you, too, Big."

"And what orders do you propose to give?" Hilda asked.

"I don't know yet. I haven't thought about that. But, anyway, when there are orders, it'll be me who gives them. I just wanted to make that clear."

"Come here, Nila," said Farley.

For a fraction of a second Nila wilted, then she became twice as defiant as before. "I tell you I'm the boss, Big," she declared. "I'm going to decide what's to be done. You told me yourself I'm the only one among us who has any hope of understanding machines."

"Come here," Farley repeated.

"I'm telling you . . ."

Nila began—then darted for the door.

But Farley, though slow in comparison with Nila, had narrowed the angle so that she couldn't get past him. Hilda and Eric watched, interested but not feeling themselves involved.

Farley sat on a sofa, dragging Nila after him, and pinned her legs together between his knees. What she did with her hands, which he had left free, didn't seem to bother him. Actually she was beating a tattoo on his head with her fists.

He bent her over his knee, gently but quite firmly, and held her with one vast hand at the back of her neck. Nila shouted with rage and made ineffective scooping motions with her arms.

Farley didn't use anything but his hand. However, that's like saying a shark didn't use anything but his teeth. It was a hand like the paw of a giant bear, and every time it landed on the tightly-stretched grey slacks, the ornaments in the room rattled and a crystal vase pinged. Nila took the

first two in silence, but yelled with all the power of her lungs after that. Hilda, remembering how she had once fared at Nila's hands, thoroughly enjoyed the demonstration.

Anyway, there was no risk of Nila being seriously hurt as long as she could yell like that.

"Any time you want me to stop," said Farley conversationally, without pausing, "just say so, Nila."

"Stop!" Nila screamed.

Farley let her straighten up, but kept a grip on her wrist. "Are you still the boss?" he asked gently.

"Yes! Just you wait till I—No, Big!"

One more smack which sounded like a wooden beam snapping was enough. Nila stood up, red and breathless, and capitulated. She burst into tears, hiding her face in her hands.

"That's for your benefit, Eric," said Farley. "She wouldn't try it on me or Lady Hilda."

It wasn't clear who moved first or most. At any rate, almost at once Nila was in Eric's arms, still sobbing.

"Look and see if there are any real tears," Farley advised.

"I'll come and dance on your grave, you big slob," Nila snapped, without any trace of a sob in her voice. But she didn't release herself from Eric's arms.

Later Eric told Hilda, frankly: "It wasn't only because she was crying. I liked her a lot better when I saw someone could handle her. I mean, you and I have both tried and failed. It was nice to see that someone *could* get the better of her—even if it had to be Farley."

"You think perhaps you could do the same, with practice?" Lady Hilda asked, amused.

"I think perhaps I could," said Eric seriously.

Nila was talking to Farley, without malice. "But look, Big, I've got to know what you're driving at. What exactly is the position?"

Farley told her. He himself didn't fully understand the embezzlement he had operated—he had a habit of doing things, effective things, without fully understanding them. However, it had meant less money for Centre and more for himself, Wyger and Camisac. It couldn't be set right in a moment, but it could certainly be set right in two years.

"You're sure of Wyger?" Nila demanded.

Farley nodded. "He's for Camisac, himself and me in that order. The way I've left things, he has to whitewash himself and me if he's to save Camisac. By the time Camisac is investigated again, Wyger will be ready for it."

"But that won't do any good," Nila exclaimed, "when Hilda and Eric testify against you."

"I just have to make sure they don't."

Nila stared at him. "They're bound to."

"Maybe not. In a way I *am* holding them to ransom. They

can go back in two years, when Wyger has covered our tracks—or now, if they promise to see we get the two years anyway."

"Ah," said Nila softly. "That's better, Big."

"They've got to realise their own uselessness, Nila. I want them to get bored and feeling helpless, and they'll compromise."

"Lady Hilda won't compromise."

"Think not? In a few weeks more it'll be completely obvious that unless she does, she's going to be here for two years, perhaps a lot more."

"So?"

"Two years doesn't matter to me, or to you, so long as you can find something to occupy yourself. But to the others—don't you know how impatient Eric is?"

Nila grinned. "Leave Eric out of it. From now on, I'm taking care of Eric, I think. But Lady Hilda's still your affair. How about her? She's pretty patient, surely?"

"She's not so young as she

was," Farley murmured. "She's reached a stage where two years count."

Nila waited. She didn't quite understand.

"These are Lady Hilda's last two years of being an attractive girl," Farley went on. "She doesn't want to waste them. Very soon now people will be saying 'Of course, she isn't a girl any more——'."

Nila nodded admiringly. "I hand it to you, Big," she said. "You aren't overloaded with brains, but you have enough."

She grinned wryly. "I even forgive you for lamming into me today. Seems that was just what Eric needed to make him appreciate my... finer points."

It was. Nothing further was necessary except one or two things which were entirely between Eric, Nila and the stars—without, as far as the others knew, any more fights.

The contract being as it was, there was no need for any ceremony when Nila and Eric were married. Lady Hilda signed the certificate, Farley

signed it, Eric and Nila signed it, and that was that.

"Are you *quite* sure," asked Nila as naively as she could, "that you aren't being trapped into something?"

"I'm quite sure I am," Eric retorted, "but I fail to see anything I can do about it."

They both laughed.

Nila turned to Hilda and Farley. "Goodbye," she said, and held out her hand.

"What do you mean, 'good-bye'?" Farley grunted.

"We're going away on our honeymoon," she said happily.

"Where? You can't go outside the city."

"Who said anything about leaving Mellice? It used to hold two hundred thousand people—it should be big enough for four. We're going away where you can't find us, that's all. Just for a week."

"How about me?" asked Lady Hilda. "Don't I need a chaperon?"

"You should know, not me," retorted Nila.

Before they went, Eric mentioned the subject again, when he was alone with Lady Hilda. "We won't go if you don't want us to, Hilda," he said.

She shrugged. "If Farley had ever intended to force himself on me, your presence or absence wouldn't make the slightest difference."

"I didn't mean what he *intended*. I mean . . ."

"You mean, left alone with me, his resolve might weaken?" she smiled. "You know, Eric, I've been surprised very much by Farley's self-control. I don't think he'd ever make a mistake by being rash."

Eric was obviously unconvinced.

"In fact," she went on, entirely to herself, "I'm just wondering whose self-control is going to crack first, his or mine."

"I don't understand you, Hilda," said Eric.

Lady Hilda became herself again at that. "Well, there's no need to boast about it, Eric," she said gently.

Eric refused to take offence. He was obviously in love, and couldn't be concerned for long over anything which didn't involve Nila.

"Why did you want us to get married, Hilda?" he asked curiously.

"I didn't, I——"

"Oh, you know what I mean. You had some idea or other."

Hilda looked thoughtful. "I was merely thinking of what would happen if Nila had a baby. None of us knows anything about childbirth, and Farley has strong affection for her—he'd take her to a doctor or bring one here. And though I don't want to stay here even nine months, it's better than two years——"

Eric let out a shout of laughter. "You and your complicated schemes!" he choked. "You don't know Nila." Lady Hilda heard the pride in his voice, and any doubt that he was in love disappeared.

"She says she could have a

baby without any help if she had to. But if it does happen, she's going to tell me what to do, and——"

"You!" Lady Hilda exclaimed.

"Yes, why not?" asked Eric defensively. "We think it's a good idea. Husbands and wives should share things—even having babies."

"You must have been doing a lot of talking lately," said Lady Hilda drily. "Anyway, good luck to you."

"You're sure you don't want us to . . . ?"

"I'm sure."

She wasn't, really. She couldn't pretend that she wholly understood Farley, and she was curious to see what it would be like without Eric and Nila around, how he would treat her when they were alone.

She found very soon that it was exactly as she had expected. Farley was as correct as ever. But for a certain clumsy gallantry that appeared only very occasionally, when he remembered, he treated

her as a sister—which, no matter how convenient it might be, was also bound to be a little frustrating. She sometimes found it very hard not to make an attempt to shock him out of such casual behaviour.

There was no question of wanting him to make love to her—none at all. But it was utterly unbearable that he should show no sign of wanting to.

Lady Hilda was very glad indeed when the week was up and Eric and Nila returned, still blissfully involved with each other. She had had no fear that Farley would do anything that she might regret—not after all this time. However, there had been a considerable risk that she would.

They had been in Mellice just a month, and Lady Hilda was bored. Farley, not unduly sensitive to atmosphere, could feel boredom oozing out of her, and rejoiced.

It was evening, too hot to

stay inside. All four of them had been lounging on the veranda, but Eric and Nila had slipped quietly away together. Already Eric was melting under Nila's influence. He hadn't shown any sign of impatience or resentment, and had only been uncivil to Farley once since he and Nila were married.

Lady Hilda was just about at the end of her tether, Farley calculated. She could endure anything provided there was a challenge in the endurance. Mere waiting undermined her steely self-control, as Farley had guessed it would. She was like Nila in that. Neither of them could flourish in idleness.

Farley had known very well from the start that he was the only one of the four who had any long-term patience at all. Lady Hilda could control herself better over short periods, undoubtedly; over days, weeks, months, he knew he had the advantage.

The decline, as far as Hilda was concerned, had been rapid.

It was only a week since she had begun to betray her impatience, to snap at Farley almost as Eric had once done, and to move about restlessly instead of relaxing luxuriously at any opportunity. Two days before she had made herself look foolish, probably for the first time in years. She had tried to provoke Nila and had given Nila the opportunity to be generous, understanding, and to refuse to take offence.

"Why won't you talk, Farley?" Hilda demanded suddenly.

"I speak only when I'm spoken to," Farley replied.

She was wearing a yellow and black gown which made her look like a tigress as she strode restlessly about.

"You still think you can get away with this?" she asked tauntingly.

"I hope so," said Farley easily. As Lady Hilda lost her self-control it was becoming more and more easy for him to retain his.

She seemed to realise that.

She came and stood over him as he lay comfortably in a swinging chair, smoking his pipe. And in her restless, reckless mood she made a sudden attack on his self-control.

She bent over him, pushed his pipe aside and kissed him.

"I wouldn't do that if I were you," said Farley, after a long pause.

"Why not?"

"If you do it again I'll probably follow it up."

"Again, why not?" demanded Lady Hilda. "What does it matter?"

"You realise what you're saying?" asked Farley quietly.

"I always realise what I'm saying."

"I didn't think you'd—I thought I disgusted you." He was shaking with the effort to keep himself under control. It wasn't desire that incapacitated him, it was shock. This was an utterly unexpected development. He couldn't believe it was happening.

"Women aren't so particular about men," said Hilda

indifferently. "You're not dirty and you're not fat. I don't mind you being big—even that big."

"Let's work this out," said Farley, with an effort. "Instead of this, which would probably suit my plans very well, suppose we——"

"If you could get what you want two ways," Hilda interrupted, "one including me, which way would it be?"

"Look, Lady Hilda," said Farley desperately, "this is as much as I can do, without you . . . I've always admired you and looked up to you. I'd have loved you if I dared."

"And, funnily enough," said Hilda, with a grin, "I've always had a sneaking admiration for you, Big. I've wanted to call you that, too. Forget Camisac and how we come to be here. All that will still be true tomorrow."

She sat on the chair beside him and raised his huge head in her two hands.

"No!" shouted Farley, jumping up and spinning

Hilda into the chair, which rocked violently. "I'm not a highly moral character, and I want you, Lady Hilda—but I won't have you just because you're so bored and fed up and disgusted with yourself that you can't think of anything else to do."

Hilda gasped. Farley had spoken with a power she had never expected of him. He had never been really articulate. Now, suddenly, she realised that, after all, he must have got into power as Premier of Camisac by making speeches, among other things. He might not be a great orator, but he must be convincing at times.

"I brought you here," Farley went on vigorously, "so that you'd see something. You and Eric are authorised to settle the fate of a world and its people. I'm the ruler of the world. And we're three very useless people. Absolutely at the mercy of Nila, who's nobody in particular."

"You said that before."

"I know. But I didn't say what it meant. Humanity is on the downgrade. The talent and intelligence isn't there any more. Most people are like you and Eric and me. Anyone like Nila is bound to get on, because there aren't so many people like Nila these days."

"Nonsense!" Lady Hilda exclaimed. "Everybody's tested, and the tests show——"

"The tests show what we make them show. We check the population against the population. And even when they do show talent, they can't show how or whether the person concerned is going to use the talent. I tell you, we're on the downgrade."

"You talked of a swing of a pendulum. But this isn't just a swing. It's decline."

He was talking as she should have known he could talk, if he wasn't awed by the person he was talking to—with sledgehammer force, conviction and sincerity. She wilted before it. She only had reason and intelligence

with which to oppose all this power and certainty.

She was disturbed, but she rallied. "It isn't so, Farley," she exclaimed. "What counts in the end isn't talent or intelligence. It's spirit—courage—drive, if you like to call it that. And you've got it, Farley. Nila has it. I have it. So long as that's so, there's no decline."

Farley let out a great bark of laughter.

"What are you laughing at?" Lady Hilda demanded, almost petulantly.

"You agreeing that drive is the only thing that matters. Yet still determined to evacuate Camisac. *My* Camisac."

Hilda began to make an angry retort, not quite knowing what it was going to be. But Farley went on, forcefully:

"You haven't *drive*, Lady Hilda. Your ancestors had, but it's been worn and sweated and overbred and refined out of you. So while you talk and act bravely enough, you find yourself always preferring

the course that the times seem to demand, the course of decline, the course of apathy—the easy course. Evacuation, consolidation, not expansion, experiment. Your vitality is all gone and you don't even know it. You——"

Lady Hilda couldn't take any more. She didn't know whether she was resenting brute force, escaping from ignorance or running away from the truth.

It was too much for her, anyway. She jumped from the hanging chair and ran past Farley into the hotel.

At the top of the hill Lady Hilda looked back for the last time at Mellice.

She wasn't quite sure why she was doing this. It might be because Farley was becoming more attractive to her, and because it would be mad to ally herself with Farley. It might be out of sheer boredom, for something to do. It might be to anger, upset and frighten Farley, for he would have to search for her and

would almost certainly fail to find her.

But undoubtedly, she admitted to herself, Farley's taunt that her vitality was all gone played a big part in her decision. She had to prove, to herself as well as to him, that she had as much courage and determination as he had.

It was just after dawn. She had left a note saying she wouldn't be back until late afternoon. That seemed to be the way to win herself most time. If she had said she would be away for days Farley would have been suspicious and started looking for her at once. This way, nobody would do anything until the evening, and probably no serious effort to trace her could be made until the next day.

Without lingering over her last view of Mellice, the only place on the whole planet where human beings were to be found, Lady Hilda turned and went on over the hill, looking too clean and neat and attractive to be an ad-

venturer, but really almost as much a pioneer as her ancestors.

Determined, after Farley's taunts, to do something, she had soon found the only thing she could possibly do.

It was anybody's guess when the ship which would almost certainly visit Undrene looking for them actually came. It might arrive in a month or not for six months. The chances that it wouldn't arrive in the next three months were fairly good.

Lady Hilda was going to be in Martinburg to meet it.

She remembered the remarks which had been made when the journey to Martinburg had been mentioned. Farley had said he could do it and that was probably true. Nila claimed to be able to do it, too. Well, if they could do it, Lady Hilda was determined she could.

She had nothing with her but her clothes, three knives, a compass, a waterproof lighter, a map and some concentrated food tablets. Her

clothes were a brown shirt and shorts, a leather belt and stout sandals.

The dangers of the venture, though considerable, were simple enough. Undrene had no intelligent life, no reptiles, no insects, nothing but warm-blooded mammalian animals. So there was nothing but the animals to fear. They were quite enough.

None of them resembled closely any variety with which Hilda was familiar. But then, she wasn't familiar with animals at all—Centre had none except a few domestic pets. However, as on most worlds, they could be classed under the old Terran heads. There was something that could be called a lion because of certain superficial similarities; something that was coloured like a tiger and, therefore, was called a tiger; a fierce, stealthy, black killer which filled the place of the panther; a timid, harmless creature which lived by running fast, like a deer; and there were wolves, fortunately not many of them,

so-called because they were about the size of a wolf and hunted in packs. The wolves were the greatest menace of all, but there were not many of them because every other species on Undrene combined to keep the wolf packs down.

That was all. Undrene's terrain didn't offer any difficulties; it was firm, soft and never overgrown as so many warm worlds were. The climate was easy, with warm nights and not too hot days. There was plenty of fresh water, plenty of fruit and vegetables, in sufficient variety to live on, and the air was clean.

All Lady Hilda had to do was avoid a fatal encounter with any of the thirty or so species which could kill a man—or woman.

She had her first indication of how difficult that was going to be before she was five miles from Mellice. With no warning whatever, a wolf sprang at her. It came at right-angles from nowhere, and only Hilda's automatic

reflexes prevented the first attack from being completely successful.

She dropped on one knee, head down, and the wolf's heavy body struck her shoulder with numbing force. She was up at once and running, knowing quite well that running wouldn't do any good. There wasn't the slightest chance that the wolf had been injured, and it could probably run three times as fast as she could. However, she heard nothing behind her, and so long as nothing stopped her, the thing to do was obviously to get as far away from the wolf as possible.

She must have run two miles. Only when it was impossible to go any further did she stop. She climbed on a rock about forty feet high, with the branches of half a dozen tall trees as a roof, gasped until at last the pain went out of her chest and she ceased to hear and feel every heart-beat, and tried to think calmly.

She had been very near

death, and the cause had been a single wolf—a rarity, one of the lesser dangers of Undrene. She had no idea why it hadn't chased her, but perhaps by supreme good luck its attack on her had brought one of its own enemies on the scene. What would happen the next time was obvious. To go on toward Martinburg was death—not eventually, for with experience she would become a less easy prey, but immediately, before she had gained that experience. Within the next few hours, probably.

Presently she found herself calculating the chances quite calmly. Yes, that was so. The first day, when she knew nothing, would be the worst, the second a little better, if only because she would have lived through the first, and if she wasn't killed in the first week she might not be killed at all.

It was true, of course, that the only reasonable thing to do was get back to Mellice at once, if she could. How-

ever, she had already decided not to do the reasonable thing. And that being so, she might as well be on her way.

Farley would probably come after her sooner or later. It had to be Martinburg, which was unfortunate—he would be in no doubt whatever which way she'd gone. However, it was easy enough to ensure that he didn't find her, and she was pretty certain he wouldn't go all the way to Martinburg after her.

Farley, chasing her, would have to take the straight way, which was north-west. If she were to make a detour, there were too many possibilities for him to cover. So she was going north-east, knowing that in a couple of days it would be safe to turn north-west in the reasonable certainty that Farley could never find her.

She made good progress; provided nothing killed her she was bound to, on a two-thirds G planet with smooth ground and few sharp hills.

By the middle of the fifteen-hour period of sunlight she was about twenty-five miles from Mellice, dead tired and ravenously hungry.

And she stopped and tried to think calmly again. She had done nearly a hundredth of the distance she had to travel, had nearly lost her life, and at that had probably been fantastically lucky. But now the question of returning to Mellice was complicated by the fact that if she turned at once she could barely reach it by sundown, anyway. In fact, she couldn't. She had done very well so far, and couldn't expect to do more than another ten miles or so that day.

So she was already committed to a night in the open.

Suddenly she laughed. Obviously, all along, she had been determined to place herself in this position. She must want to get herself killed. Now already she was telling herself it was too late to go back. She would keep saying that until she reached

Martinburg or died under the claws of some wild animal.

The thought made her shudder, but didn't prevent her falling on the fruit and raw vegetables she had been collecting, with an appetite that she had never been able to produce for the magnificently-prepared meals which the larder of the scout had provided.

After her first night's sleep, high in a tree, Lady Hilda would gladly have returned to Mellice if she could have been transported there.

Sleeping was no difficulty. She merely fastened herself by her belt as comfortably as possible, shut her eyes and slept. And sleeping in a tree was safe enough on Undrene, she knew. Few of the really dangerous animals could climb trees.

No, what turned her optimism to the blackest pessimism was how she felt when she opened her eyes. Every muscle she possessed ached—

she knew because she could feel them all. Her neck was so stiff she could hardly hold her head upright. Her shoulder, too, was stiff and sore where the wolf's body had struck it.

There was nothing in the galaxy she wanted as much as a soft bed.

She thought more seriously of returning to Mellice than she had done during the whole of the previous day. Danger, after all, seemed less important than discomfort. It was easier to face the thought, even the near certainty, of being killed than to feel as she did now and go on.

She need never sleep in a tree again. That night she could be back at Mellice. The longing for a hot bath and a cool, soft bed afterwards made her almost physically ill.

Besides, reviewed in the present circumstances, her reasons for escaping from Farley didn't seem so overpowering.

She had brought no watch, but by the position of the sun it couldn't be much after dawn. As she looked up through the branches and calculated, the gleam of water caught the corner of her eye. Over to the left was a lake which she hadn't noticed the night before.

The thought of a cool swim didn't attract her much. She was too stiff and sore to like the idea of moving at all. However, after a swim she couldn't feel worse and might easily feel a lot better. And there was one very attractive thing about swimming on Undrene. None of the more dangerous animals were good swimmers.

Hilda climbed down, feeling like death, and stumbled towards the lake. Reaching it, she took off her clothes gingerly—even that was an unpleasant undertaking—and hid them between two stones. Without enthusiasm she slipped into the water.

It was glorious. The water seemed to dissolve the stiff-

ness in her muscles at once. She swam about in increasing delight. This wasn't ordinary water, obviously. Vaguely she remembered having read of Undrene, in an old book, as a spa. It had attracted as visitors the curious mixture of sportsmen and invalids. Lady Hilda was sorry there had been anything to attract sportsmen, but very glad of the restorative powers of Undrene's water.

When she came out of the pool and put on her clothes it was with considerable regret. She was hungry now; before, food, like everything else, had seemed unimportant compared with her aches.

Probably that swim made the difference between returning to Mellice and going on. Even if she had decided to go on, the first mile, without the swim, would have been enough to turn her back. As it was, she was borne on her way for about three miles by the pleasure of the bathe and the effect it had had on her aches and pains. After that she had

something else to think about.

She was walking along, rapidly but not carelessly, minding her own business, when, with as little warning as on the previous occasion, she was attacked for the second time. And this time there was no chance to run.

The beast which attacked her was known as a tiger because of its yellow and black skin. But in method it resembled a bear more. It ran on four legs, but rose on the back two to fight, and its method was partly to crush, partly to fall on its victim and break his back, and partly to tear his throat with its teeth.

This tiger came at Hilda with the obvious intention of doing all three. And she knew that if she was to get away alive, she had to kill the tiger.

When it came at her first she didn't have time even to pull a knife from her belt. So she screamed in its face and kicked it on the leg. Both measures were surprisingly effective. The tiger reared

away from the scream, clearly startled, but not in time to avoid Hilda's vicious, terrified kick. The injured leg folded swiftly upwards, decidedly damaged, and the tiger screamed soundlessly—it had no vocal chords.

The tiger appeared to have no thought of flight. It dropped on three legs to bound at Hilda, straightening itself in the air. And since for her own survival she had to be savagely effective, she was. She turned aside but hewed the air violently, without looking, where the tiger's heart should be.

Again there was a violent blow on her shoulder—the other shoulder this time—and she was thrown, dazed and rather sick, on the ground. Dizzy though she was, she rolled to her knees, ready to jump up—and watched the tiger die.

That she could have killed the tiger so relatively easily was explainable, once it had happened. She had, after all, one and a half times the

strength she should have, on this planet. She was faster and stronger than any of the animals of this world had any reason to expect a creature like her to be. It was no wonder that her kick had put the tiger's leg out of action, nor that her vicious, tearing knife-stroke had torn the tiger's front open.

The encounter had added to her injuries, splattered her clothes with blood and scared her half to death for a while, but these things were nothing compared with the lift she got out of it. She had a chance after all. *Everything* wasn't loaded against her on this planet. If it was possible to meet a tiger and kill it like that, without experience, without any particular stroke of luck, and without permanent injury, there was no telling what else might be possible.

She might reach Martinburg safely after all. Only two hours after being on the point of returning to Mellice, defeated, Lady Hilda walked on resolutely towards Martin-

burg, irrevocably set on getting there.

The next day she wasn't so stiff; and, as if to entice her further and further from Mellice, she had no dangerous encounters.

The fourth day, when she was well over a hundred miles from Mellice, made up for the first three. Beginner's luck is always more apparent to everyone else than to the beginner; the beginner doesn't know he's lucky, not seeing the difficulties he somehow avoids in total ignorance. Lady Hilda had been allowed three days to find her feet in native Undrene, but on the fourth day Undrene hit her with all it had.

She ran from a creature something like a pig, aware that she could probably kill it but not looking for trouble. She had not, so far, been able to bring herself to kill, cook and eat an animal. The idea made her shudder. So there was no point in killing the pig if she didn't have to.

She got away from it all right, only to run almost down the throat of a crocodile. Breathless, exhausted, she was almost helpless.

It wasn't a crocodile, of course, except in one particular. It was a mammal with a short, fat body, short but quite effective legs—and a mouth with razor teeth which accounted for half its length. Its mouth was its only weapon, but as far as Hilda could see that was quite enough.

She didn't panic. She had found already that she couldn't panic if she tried. Finding a small reserve of energy from somewhere, she skipped back and avoided the first snap of the beast's ponderous jaws.

There must be some way of handling this creature, she told herself. She had strength and intelligence, and those two things should be able to take her to Martinburg—certainly past this clumsy menace whose only weapon was its teeth. However, she couldn't see how. If she could

get at the crocodile's body it would be easy enough to kill it—but those cruel, snapping teeth were specifically designed to prevent that. She tried running, experimentally, but wasn't surprised to find the animal could run faster than she could, at any rate in her present breathless state.

For three minutes or so she managed to dodge the crocodile, without gaining any advantage. It was obvious now that she should have learned to throw a knife, so that she would be able to attack without coming to close quarters. A knife thrown hard down the creature's gullet, she guessed, wouldn't do it any good. A suitable stone might be a quite effective alternative. Unfortunately there were no suitable stones about, and she could hardly go and look for one.

When it was beginning to appear that she was going to spend the rest of her life dodging this creature (her life ending when at last she failed) Hilda noticed a stout

stick lying loose on the ground. It was behind the crocodile, but gradually she worked round until she could make a dash for the stick. When the creature came at her again, jaws snapping, she stayed to meet it and smote with all the strength in her body.

Probably she had never before hit anything as hard as she could. Movement in a civilised society is a thing of calculated effort, seldom the greatest possible force, usually a matter of enough and no more. But this was a matter of life and death. Hilda brought the stick round in an arc which ended at the side of the crocodile's long mouth with a snap that seemed to startle the whole forest into silence.

The crocodile had vocal chords, obviously. It let out a screech and scuttled away. Though Hilda had seen no sign of damage, the beast had clearly had enough.

Evidently she needed a stick as part of her armoury.

This one had already saved her life. She could do much worse than take it along.

It didn't last for long. Less than ten minutes later she met another crocodile, smaller and more vicious than the first. She attempted to deal with it the same way, but it closed its jaws on the stick and snapped it like a match-stick. Hilda, by this time, was wasting no time in waiting to see what happened. As the creature's jaws closed she kicked it hard under the chin, guessing that would be a vulnerable spot.

It was. The second crocodile, like the first, screeched and fled.

This is all very well, Hilda told herself, looking for another stick, but no insurance company would accept me as a client at this rate. Gaining experience is a risky business.

Before midday she had her most serious encounter yet. With her second stick and a knife she drove off a lion, but not before it had thrown her

twenty feet, bruised her ribs with one casual swipe, torn her shirt and scratched her with another, and demonstrated quite plainly that if it were really set on it, it could kill her before she killed it.

And after that, when she found herself still going on, Lady Hilda realised for the first time that she was quite as obstinate as Farley.

It didn't matter what happened to her, apparently. Nothing was going to change her mind. So long as she was capable of going on, she found herself going forward, not back. That was the pioneer spirit, she supposed. She had never understood it before, and even now she didn't understand it. It was crazy to continue on a course which meant practically certain death.

She was still safe, but it couldn't last, and she knew it. If the lion had been hungrier, if she'd stumbled when dodging either of the crocodiles, if the tiger had been a little more cautious, if the wolf had

followed her—she would be dead. As it was, both her shoulders were bruised, stiff and sore, one side was numbed and there were three deep scratches, miraculously only two inches long, across her diaphragm just above the waist. Also, but for a convention of civilisation which she knew quite well was inapplicable here, she would have thrown away her torn shirt, which was hanging together by a thread.

That day she met, in all, three crocodiles, a lion, two tigers, a panther and five pigs. The most dangerous encounter remained the one with the lion, though from some points of view her narrowest escape was when a mighty blow by the panther tore out a handful of hair without actually touching her head. She didn't know what happened to the panther. At the first chance she got she ran, and there was no pursuit. It seemed that running was the way to stay alive on this world.

Evening found her, however, still on her way. "Apparently I want to die young," she told herself philosophically.

Lady Hilda had a good run for her money. Quick thinking and acting, courage, resolution and, undoubtedly, good luck kept her safe for fifteen days.

At the end of that time she was much tougher and wiser than she had been at the start. She was tanned brown, her skin whole and glowing. The bruises had gone and only three specks of white showed where the lion's claws had bitten—she had always healed easily, and bathing in Undrene's spa water, which she did whenever she could, helped. She carried with her, all the time, a tough thick staff as tall as herself.

On the sixteenth day she came face to face with a tiger. She had killed four tigers and driven off seven. While she knew better now than to

treat any wild animal with contempt, there were many she would have liked less to encounter than a tiger. Tigers were comparatively soft. She couldn't make much impression on a lion, a panther or a crocodile without her knife or stick, but tigers were more vulnerable, and she thought she could damage one considerably without weapons.

She soon had an opportunity to try.

She brought her staff round in a swing which was meant to break the tiger's head. For once she misjudged the conditions and the tip of the staff crashed heavily on a branch above the tiger's head. The staff jumped from Hilda's arms, numbing them. The tiger, unconcerned over his escape, closed in—and in drawing her knife hastily, Hilda dropped it. She lashed out with her foot, uselessly, for as she did so the tiger leaped and came down on top of her.

She managed to turn so that the creature didn't crush her

beneath it, and she was borne to the ground and was at once fighting to avoid the tiger's teeth. On the ground the tiger was quite at home, while Hilda's effectiveness dropped by more than half.

For fully ten seconds she managed to avoid injury—which was a triumph of self defence. At the end of that time she made the mistake of going for her second knife. The tiger's head darted forward; Hilda saw its teeth opening wide to clamp together in her neck, and realised that she wasn't going to see anything else.

She was wrong. She saw the tiger's head explode. Her reflexes were so good that even that supremely unexpected happening couldn't take her unawares. She rolled clear and got to her feet so quickly that hardly a spot of blood fell on her.

Farley was standing only ten yards away, his gun still pointing at the tiger.

"So it ends," she said calmly. "I don't know whether

to thank you or . . . yes, I must thank you. Have you been on my trail long?"

"Since the beginning," said Farley quietly.

She jumped convulsively, more startled than when she met the tiger. "Since the beginning?" she echoed blankly. "Why did you let me go on?"

Farley stroked his bearded chin thoughtfully. "I knew that would be the first thing you'd ask," he said, "but I could never work out what I'd answer."

In shorts and sandals he was vast and hairy, and grimly powerful, yet he didn't look the brutal savage she'd have thought he would look like that. There was, after all, a certain fineness in his face, a hint of something above the beasts. Having seen nothing but beasts for more than two weeks, Lady Hilda could see it clearly, despite the ragged black beard and moustache which covered the lower part of his face. A near-nakedness

removed from him a good deal of the clumsiness and bulkiness which were always apparent when he was fully dressed. The setting, too, made a difference. Here, Farley could not possibly be out of place. He was the man above all men to have as a companion in such circumstances.

"Why did you let me go on?" Lady Hilda repeated, wonderingly.

Farley shook his head. "I don't know. Any more than you know why you went on."

That struck home. "If you'd turned," Farley went on, "I'd have shown myself. Or if you needed help. But you never——"

"You killed the wolf, the first day!" Hilda exclaimed. "And the panther, the fourth day. And..."

He nodded.

She felt frustrated. It was one thing pressing on alone, relying on no one but oneself. It was another thing altogether sticking one's head into trouble, with a body-

guard behind to intervene if things got too tough.

"You couldn't have been just behind me all the time!" she exclaimed.

He shrugged. "No, so long as I caught up with you and saw where you slept, I——"

"Where were you the second day when I killed the tiger?" she demanded.

"What tiger?"

"Didn't you think I needed help when I fell in front of that lion?"

"What lion?"

Lady Hilda relaxed. "That's better," she said. "I had to do some things for myself, then."

Farley grinned. "You had to do everything for yourself. Until this. And you weren't up to standard today."

"No," Hilda admitted. "Suppose I'd got all the way to Martinburg? Suppose you'd never had to show yourself?"

Farley shook his head. "I just don't know, Lady Hilda," he said slowly. "All I knew was, so long as you kept going—you must have known

you were going to be killed sooner or later—I couldn't take you back, a prisoner. Maybe I thought that if I waited until I had to save you . . ."

She nodded. "Fair enough. Now it's been demonstrated that I wasn't going to get to Martinburg. So you don't feel so bad about taking me back."

He paused awkwardly, wanting to say something and not knowing how to do it. At last he blurted: "You were magnificent, Lady Hilda. What I said about you was all wrong. I always admired you, hoped you were like this, but never believed it."

She laughed helplessly, not knowing why. "Please don't call me Lady Hilda," she said. "It seems so absurd."

She dropped on the ground and laughed at the strangeness of the situation. Farley dropped beside her anxiously, obviously suspecting hysterics. Still laughing, she put her arms behind his back and pressed his lips against hers.

"Please, Lady Hilda!" he exclaimed.

"Fool!" she told him, laughing. "What else do you think we can do? Didn't you know when you followed me that this would have to happen? We're five hundred miles from anyone else, and we've the whole way to go together. And don't you realise that after all this I can't jail you, or have Camisac evacuated, or . . ."

But she didn't really want to talk.

It wasn't until late in the evening, when they had covered quite a few of the many miles back to Mellice, that she became once more anything like the Lady Hilda Farley knew.

He still couldn't believe that it was all over, that she would refuse to press charges, that Camisac would get another chance, that he had won all he had been fighting for, that she *could* guarantee all she was so casually promising. She smiled and said that in the

end good administration came down to the level of human relationships—a remark which he didn't quite understand—and then went on to something he did understand.

"You were fighting a battle," said Lady Hilda slowly, "trying to settle something. You were trying to make me see something that you believed, and if I did you'd win a storybook victory, like a hero who proves himself right against enormous odds. You fought so that somehow the retreat of mankind would stop and turn into an advance again, as if saving Camisac would save every planet that Centre's thinking of evacuating."

Farley grunted in protest, but she went on, coolly: "Well, nobody ever does win victories like that. Even if you could get Centre to change its policy it wouldn't be any good unless you also changed the things which brought about the policy.

"All you've done is get a reprieve for Camisac. It won't be evacuated now, but in fifty years, a hundred years, two hundred years, it will. I don't believe as you do that humanity is on the downgrade—yet it looks as if it'll be quite a while before we swing back. You've won your world back for your lifetime, probably—and that's all you've won."

"And you," said Farley quickly.

She smiled. "Maybe. Here, yes—but what happens when we get back to Camisac is another matter. I'm making no promises."

"You know how I fight for what I want," Farley warned.

"I know," she said quietly, "but there are some things you get without fighting for them—if you get them at all."

"Yes, Lady Hilda," said Farley humbly—but she knew he would fight, all the same. And, being a woman, she was pleased.

There was more than romantic journeys to this—

Time Travel Business

BY H. PHILIP STRATFORD

SIMON OLD KNEW THIS WAS going to be a tough one.

This one might louse the world up for keeps. He twitched his thin lips good-naturedly at the Chief as soon as he came into the office.

"Take a look at these, Simon."

The Chief tossed a splay of shots from photo-planning across his desk. Old sat down. The chair was overstuffed and comfortable, like the Chief. It also had steel springs hidden below the surface, like the Chief.

Old picked up the photographs and looked for referents. Across the bottom of each colour print familiar words had been stamped.

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"Bill Slazenger's work," Old said. "He gets the detail.

But one of these fine days he'll drop that damn great box of his overside—and we'll all go *phut*."

"Bill's safe enough, Simon."

"Yeah. If you say so." Old was examining the shots with a minute care his casual manner concealed. He tapped the picture with a thumb nail.

"Any prizes for guessing where and when, Chief?"

"You kidding? I asked you here because I want you to tackle it. It's a sticky one."

"It looks it."

The photographs were a sequence. A great walled city full of domes on the promontory, with the ground outside covered with men and horses and tents. Everywhere along the landward wall forming the base of a triangle the flicker of weapons and the gushing puffs of smoke. The frantic rushing to and fro of the men

within the walls. Men clambering over. Houses and churches catching fire and spreading black smoke to mingle and subdue the last remnants of white. Men in the streets. A great building on fire. Men running. Chaos. A hideous record of man's attitude to man.

"Who's paying?" Old asked, throwing the photographs onto the desk. He'd been called in from an interesting hunt on Mars—she was the daughter of a Member of Parliament and had considered Old to be terribly romantic by reason of his profession—and he was under the necessity of reimbursing his personal exchequer.

"Martin Wallenstein the Tenth," the Chief said, with a flash of humour. "He badly wants to complete his library and is willing to pay our prices. Since he gets from Neptune in a month what we're asking, he's getting off lightly."

"That's big money." Old felt genuine interest. "Why

hasn't he had anyone go back before?"

"That's the devil of it, Simon." The Chief pursed his lips—a bad sign. "Last year he retained Time Dredgers Inc. to go back to Constantinople—Istanbul—to get out the books he wants. They failed. As far as we know they didn't upset the time-continuum; but they've been very close mouthed about it all. I had Bill go back and shoot a few sequences. No sign of Time Dredgers."

"Anything of me back there?" Old felt no real wonder at asking if a photograph might already exist of himself in this world, taken some four thousand years previously, at a place that he had not yet visited. That's the sort of screwy logic you got to accept in this game.

The Chief said: "Nothing of any of us. As of this date, the books we want are still in the Constantinople Public Library and will be burnt and destroyed by the Turks in 1453. The Ministry of Chronos-

cansion have only Time Dredger's claim registered, and as they failed, that automatically lapses. Martin Wallenstein the Tenth swings enough power in the House to have our claim put through without bother, and we're the only company in the field."

"Now if we could cruise into the future from now and check up for ourselves," Old grumbled.

"The back-room boys aren't even working on that any more. They say we can only travel into the past and return along the exact same line we went in. Any alteration of the events of the past and—well, you know the answer to that one, Simon. Your neck depends on it."

"Yeah. I might return to find you're an overgrown ant sitting cleaning your feelers at this desk. I know."

"You sure love me, don't you, Simon?" The Chief grinned and suddenly Old smiled, too, in answer to that. They got along.

"In point of fact you can dicker with the minor things of the past," Simon said reflectively. "Provided you don't knock against a node——"

"Hold hard, Simon! You know the rules of this game. The government would revoke our licence and the other companies would swarm in and take over all our contracts. This is cut-throat competition, you know."

"Yeah. We're in competition with the past, the present and the future. Some career I chose."

"Can you do it?"

"Wallenstein wants the books from the Public Library you said? Any idea how many books are involved, or which ones in particular he wants?"

The Chief said, heavily: "There were 600,000 books in the library."

"Whew! And that was before printing was invented, I know. They must have worn down some ball-points—no, of course, before them, too."

"Contemporary accounts

say that 120,000 books were destroyed, burnt or sold."

"Well, that makes it easy, doesn't it?"

The Chief ignored the sarcasm. "You can't touch the ones that were sold—unless you manage to buy them, which might be a risky thing if they showed up later on in recorded history. The ones that were burnt and destroyed you could grab and substitute dummies. In this game the genuine article has attained a value almost fantastic in importance—remember the schemozzle over the tapes of the first ship to hit Mars?"

Old laughed. "That lawsuit became quite famous—at least, it established our profession as a legal and respectable pursuit. But the guy who forged the log-tapes of that spaceship must have been a genius—and they were much more dramatic than the genuine ones."

"True. But they weren't worth the film they were recorded on, whilst the origin-

als, dull though they might seem to us, fetched a cool half-million."

"All right, Chief. Give me a couple of weeks to get organised and——"

"Uh, huh, Simon." The Chief was pursing his lips again. "You start in two days."

"Hell, that's short; but if you say so . . ."

"We might be tripping gaily over thousands of years, Simon; but we need the money from Wallenstein inside a fortnight. That's the way it is."

"If you'll authorise a crew and a ship. Oh, and I'd like to talk to Bill. I gather he won't be coming? No? I thought not. Who are you giving me?"

"Bill's needed for a Martian canal job. I can let you have Peter Manston as your second. Normal crew. You'll take ship three. And, Simon." The Chief paused and his hands played for a brief moment with the recorder on his desk. Then he said, heavily: "You'll

be taking Conrad as trainee scanner."

Old choked back the words that came to his lips. He nodded briefly, then stood up, his lean face expressionless.

"Okay, Chief. I'll prepare everything and let you know when we take off."

"Right. And, Simon, this is a tricky one—so watch your step."

"I'll remember. I'd hate to find you an ant, Chief."

Old went out, grinning in spite of himself, and tried to believe that Conrad wasn't such a headache as he knew he would be.

In the Time Travel business you learned to play hard and for keeps, otherwise, you just wouldn't be in business any more. And a time scanner who made a muff of a job—providing the mistake hadn't altered the time continuum so that his environment changed out of recognition—would stand as much chance of being taken on by another company as a space-pinnacle in the field of Jupiter. As far

as Simon Old knew his lifeline in this civilisation was the original time track. But any time someone drastically altered some important event of the past which influenced the future—a nodal point—a whole new time track would commence from that point and expand alongside the original. So far the boffins hadn't been able to cross-track through the resulting parallel dimensions—when they did, some very interesting world-states might result.

A world-state that was the direct outcome of Simon Old kissing a girl back in the Twentieth Century, for example. Time scanners had quite a responsibility. And the Ministry of Chronoscansion never let them forget it. Old's lean face was still carrying a trace of the smile with which he had left the Chief's office as he told himself not to worry. The Ministry boys were breathing so hard down his neck he wouldn't dare pick a single flower from the field where the first ship

had landed on Venus. That act might cause all the difference between success and failure—which would mean a different Earth today and, very likely, no Simon Old.

Although, he reminded himself soberly as he turned into the passageway leading to the crews' quarters, he could tamper with the past, in a very limited fashion, providing he knew exactly what he was doing and the results of his actions.

"Hey, Simon! Thought you were on Mars?"

"Hi, Pete. So did I. The Chief thought otherwise. You've volunteered with me for the Constantinople job."

"I have? Oh, yes. Sure. When?"

"Fourteen fifty three. When the Turks took over. There's around 120,000 books in the Public Library and Wallenstein wants 'em."

"Him? Well, the money's all right. Come on in."

Old went through into the crews' quarters. The room

was long and spacious, with bed and locker space for two hundred men. The crews of the timeships had to be treated as units of a single mind, like a Navy, their discipline and morale maintained at a peak of efficiency. Any sloppiness in their work meant far more trouble than machine-part rejects or even the wreck of a spaceship.

If these boys slipped up the whole world might go *fizz*. And nobody would know.

Old spent the rest of the day poring over maps and photographs, unable to contact Bill Slazenger, who was off on a job somewhere. By the time evening dropped over the city and chalked black smears down the soaring concrete and glass of Time Recovery's immense building he felt that he had the operation's preliminary layout firmly fixed in his mind.

Ship Three would do. She was not new, but she was bulky, a necessary virtue if she was to carry back through time even a part of the 120,000

volumes desired by Wallenstein. So far Old had given no thought to the unpalatable pill of Conrad. Now he straightened up and took one of Manston's selfigs and drew it into life.

"We've been saddled with young Conrad," he said. "The Chief wants him to get some experience. He's put in for Scanner rank."

Peter Manston made a wry grimace. "The quicker the back-room boys crack through the dimensions the better I'll like it. I'd like to know of a safe bolt-hole when Conrad begins Scanning."

Old laughed. "It won't be as bad as that. He's very young, and, even though he is the son of the moneyed partner, he'll do what I tell him on operations."

Manston's head nodded and he threw Old a quick glance which the latter didn't miss. "I'm beginning to feel sorry for the brat."

A footstep scuffed the plastic floor covering behind them.

"And who are you feeling sorry for, Mister Manston?"

They both swung round. Old took his selfig from his mouth and emitted a streamer of smoke. Manston smiled quietly and said, pleasantly: "Hullo, Conrad. Didn't hear you come in."

"I see." Conrad's young face had the thin nose and tight mouth of a son born to authority. He was used to having his own way. Old felt sorry for the kid. By the time he found out about life he might have missed a lot of it; which, to Old's way of thinking, would be a great pity for anybody.

"You're coming with us on this trip, Conrad," Old said. "You're training for Scanner, and this will give you a quicker insight into procedures than any classroom theory."

"I am aware of that, Mister Old. What are your orders?"

"Well, firstly," Old said, slightly exacerbated by the brat's freshness, "I'd be obliged if you'd check with Bill

Slazenger and ask him to set up the stereos he made."

"I'll do that, Mister Old." Conrad went out, leaving a gap of silence that was louder than a rocket take-off.

"Money!" Manston said contemptuously.

"Okay, Pete. He'll learn. Now, the plan is for us to run a scan over the city through the last days of the siege. We'll have to be careful; those boys were so full of superstition we might found a new religion and the Ministry wouldn't like that. If they were still there. Second, we dress up as Turks and make sure we are in there in the van during the actual burning and looting of the library. I estimate, depending on what fresh information the scan turns up, that we'll have some time undisturbed in the library itself before the besiegers break in. We'll know which books were destroyed and select those and shoot them back here and substitute dum-mies. Then we pull out. Wallenstein pays up and Time

Recovery pays a bonus. Check?"

"Check. As far as it goes. The scan will decide for us on final details, I imagine."

"Right. Oh, here's Bill."

Bill Slazenger popped his head in the door, shouted and disappeared. Old grinned.

"Come on, Pete. Bill's in a hurry to get to Mars."

They went out and down to the studio. Slazenger had his stereos set up and the rest of the crew assembled. They sat down in the front row and the lights dimmed. Before them the crystal globe of the stage whirled into pearly translucence, appeared to vanish behind swathes of smoke and then, as the infra-reds cut in, displayed the scene of their future operations. Or their past operations, depending on which way you liked to look at it.

"I'll spare you the sound," Bill Slazenger said, from around his enormous and filthy pipe. "It's not very pleasant."

Old let himself relax, and as

his body went limp in the softness of the chair brought his mind to a needle-sharp instrument of penetration. He wanted to soak up what had happened those thousands of years ago, know down to the last detail just what had happened in and around the library, so that when he and his crew went back there through time they would not disturb one hair of one corpse that wasn't allowed for in recorded history. He watched the stereo globe, letting the scenes sink in, visualising himself there, seeking points of vantage and hiding, and all the time vaguely aware that if he slipped up—— He thrust that away and concentrated on the siege and sack of Constantinople.

"Who's the guy with the nutcracker nose and the moustaches?" asked Manston.

"Sultan Mahomet II. Quite a big-time guy. He was the first man in history to use cannon efficiently, in a siege train, battering a city walls to rubble. Look——" Old

pointed and in the stereo a yawning cannon, almost as wide across as long, belched flame and smoke. "That's a bloke called Urban. Built and fires the thing himself. Takes two hours to load. Needs sixty oxen to pull it, two hundred men to watch it doesn't fall over and two hundred more to make a road for it."

"Gees," said Manston. "Did it do any damage?"

The shot's fall was temporarily off screen, and Old answered, lazily: "Each ball, weighing around 1,456 pounds, made a nasty mess of the walls, especially when they began to fire in salvos and undercut the structure. Mind you, an atomic warhead in a guided missile, well, they're not quite the same. But for cross-bow men, the effect was startling enough. See?"

The scene had shifted as Bill Slazenger panned across the doomed city. Tiny scurrying figures of men were frantically attempting to rebuild the sections of wall

knocked down by the guns. They worked with a will, that was plain. They had no lassitude which might be expected of certain defeat—they'd known they would all be killed just as much as did Old. He found the figure he was seeking.

"Look at the big fellow in armour." Old watched fascinated. This had actually happened. This was true. "He's a Genoese, John Giustiniani. The Emperor, Constantine XI, asked for help from the Christian world and got practically none. This chap Giustiniani was worth a whole army corps—he rallied the defence and used his brains, a terrific fighter."

Sitting in comfortable chairs in the heart of a gigantic sky-scraper, with communication with the other planets commonplace and with all the luxuries of civilisation around them, they could peer, as it were, through a spy-hole into the past and see what had happened thousands of years ago. It caught at the imagina-

tion, tugged at the heart-strings—this was a supreme example of the wonders of science. It brought those men struggling there on the stage out of dusty volumes and threw them, more than life-size, onto the living world of the present. They were a challenge and an inspiration.

"Switching to the Bosphorus, where the Golden Horn connects," came Slazenger's heavy voice. "That sharp tilted spit of land is Seraglio Point. Some ships—ah, there they are."

Four wide-beamed Genoese ships plunged through the seas and from the shore over a hundred raking Turkish galleys sped. The water flicked from their oars like contemptuous spittle into the beards of the infidels. The Christian ships ploughed on, collided, smashed the galleys, splintered their oars, rode them down, barrelled their way through. The men in the theatre were silent, spell-bound, until a crew-man at the back yelled, suddenly, breaking the tension.

"Attaboy, there! Smash through, you——"

"Quiet!" Old was angry. Two red spots danced in his cheeks. "This is a scientific operation upon which we are engaged. We cannot take sides. It's quite probable that there is Turkish blood in many of us, especially after the intermingling, and, anyway, this is dead stuff, history."

Nobody believed that history was dead stuff, of course.

The wind had died. The four ships lay becalmed, attacked on every side by swarms of long galleys. Pots of boiling pitch, stones, arrows, dead bodies, everything was flung at the wolves of the sea. The four Christian ships were the centre of a snarling whirlpool; inevitably they must sink.

Some of that ghostly miming must have affected Bill Slazenger, complacently puffing his pipe. For a brief second he cut in the sound. When it died away every man was shaken by the sheer bestiality of it.

"You'd better keep the sound dead, Bill," Old said. "Those four ships have about had it, I'd say."

"Wait," grunted Slazenger.

The wind came again, the ships' sails filled. They leaned clumsily to the wind and smashed their way through the galleys. A chain across the Golden Horn was lowered and the ships sailed through. Against his will, Old felt elated, and a faint cheer, quickly silenced, welled from the back.

"Look at him, will you?"

Mahomet had ridden his horse into the sea, was urging his men on, frothing at the mouth. His hundred or so galleys had been vanquished by four infidel ships!

Bill Slazenger said: "I won't show you what happened to the Turkish admiral. Mahomet laid him out and beat him with a gold stick. Name of Baltoglu. I've cut chunks out of the time sequence—lots of attacks were beaten off. We'll switch to the library."

Old sat through the

sequences which would affect him most. He had to have a general picture of what had happened throughout the city; but it was vital to know, exactly, what took place by the library. Slazenger, from his time scanner over the city, had been unable to shoot sequences inside the library. Old watched as Turks, their mail armour and filthy turbans marking them out from the fleeing Christians, entered the building, watched as books were brought out, torn up, burnt, carried away. Parchment scattered everywhere and black smoke and grey wreathed down the cobbled streets. The whole situation was a mess. He felt no nearer a definite plan when the sequences were finished and Slazenger had turned up the lights.

Science could transport him through time, put him down spot on the date he selected. But after that, it was all up to him. And he was only a man, just like those men fighting in the streets of

Constantinople. He stood up and yawned.

"Right, troops," he said, wearily. "Bed. We'll formulate detail plans tomorrow and set departure for the day after. No questions until tomorrow. 'Night."

Slazenger had cut the noise from his photo sequences, so that Old had been prepared for the infernal racket that hullabalooed outside. But he had been caught out by the stink. The crew had been subjected to many and various inoculations; they needed them. Old swung his field glasses across the gleaming domes of the city and watched the grey walls. Just in the angle where two walls abutted was a small postern gate called the Kerkopoporta, the Porta Xylokerkou. The date was the 29th May, 1453. This was the place and date where history had taken a decisive turn.

"Not so much noise, there," Old said peevishly over his

voices within the bloated bulk of the ship died away. Even though the noise outside compounded of a cacophonous mixture of trumpets, drums, cannon and shrieks, groans and yells hammered in like a physical blow, nothing could be left to chance. Hardcastle, the Ministry of Chronoscansion official standing beside Old's left shoulder, would see to that quick enough.

The ship hung invisible over the library. Away towards the west where the main attack was taking place hordes of Turkish and vassal bashi-bazouks, poorly armed rabble, had been attacking in waves all morning. They screamed to the ditch and walls, flogged on by *Chaoushes* armed with chain-whips and iron maces. Between the choice of these ferocious sergeants and the infidels on the walls, the Turks infinitely preferred to risk the latter. They came on in human waves, yelling *Yagma! Yagma!* Their bodies filled the ditch and made a

path for the better troops following.

"What's all that '*Yagma*' stuff, Simon?" queried Manston. Like them all, he was fascinated and repelled by the horrific scenes being enacted at this moment all around.

"*Yagma* means 'To the sack,' Pete. Mahomet used those bashi-bazouks to break down the first line of resistance from the walls, expend the Christian ammunition. Then he'll send across the janissaries. They're plenty tough babies, the best soldiers in the world."

Hardcastle, his thin face composed as though dictating a minute in the Ministry building, said: "The Janissaries were Christian boys, levied by the Turks and brought up in strict monkish and soldierly habits. They were excellent fighters."

"And some," agreed Old. "Still, Giustiniani beat 'em back, time and again. If it wasn't for that damned Kerkoporta he might have held the place."

"The Circus Gate? Yes, if that had been garrisoned the Janissaries might not have got inside and taken the defenders in flank. However, that was an isolated incident——"

"Maybe. But they'll be through in a minute or two and up sacking the palaces. As soon as that happens I'm going down and have a look inside the library."

"You're wearing Turkish clothes?"

Old grinned and shook his head. "Nope. I'm acting the part of a frightened citizen. I'll keep out of the way and I shan't disturb a thing."

Peter Manston said: "It won't matter to the time continuum if you're killed, Simon." He shot a look at Hardcastle.

"Take it easy." Old looked warningly at Manston. He could easily understand the feelings behind that remark. When you saw friends killed back in the past and knew you mustn't help because—well,

it sort of made you go sour inside.

The walls of the ship around him shimmered as though seen through a heat-haze. "Hold that damned input steady!" he growled into the mike and the walls steadied and became substantial again. If the pile failed and the ship appeared solid and real over Constantinople—his imagination boggled at the conception. He was quite calm, accepting what might come to him with a clear mind. Presently the Janissaries found the unguarded gate and burst through. Fifty of them smashed into the exposed flank of the defenders. More Turks raced in to sack palaces. The Bocchiardi brothers took the inner enclosure between the two walls back from the Turks and the fight raged on again over the bodies in the outer enclosure. Old watched the library keenly.

He hitched up the unfamiliar garments and nodded to Manston. The ship dropped

to the ground, squeezing between the library wall and the outer masonry. Old could see nothing of the fight now. He left the ship on the run, darted round an angle of masonry and fled for the library. Strangely, it was deserted, which made the whole operation infinitely more easy. He did not have a great deal of time to spare, and immediately set up his instruments and took geodesic bearings that were true with respect to the Earth's centre. He just had time to squeeze into a black recess before the first of the Turks burst in. What followed he watched with revulsion.

War had never been pretty, and this was sheer vandalism. He wondered whether these barbarians, burning and destroying, knew what it was they were breaking down this day. He had to adjust his respirator as the smoke grew thicker. After a while he judged it safe to venture out and make his way back to the ship.

Right outside the front door he saw a crowd of Turks shriek past, some carrying severed heads, and shrank back against the doorpost. He began the movement that would carry him on again when two mail-coated, turbaned Albanians broke from the main body and raced towards him. His mind froze. This is it, he had time to think; then they had halted just beside a bush growing some ten yards to his front. A sword rose in the air.

Standing stock-still, unable to do a single thing, Old saw the girl's terror-distorted face rise from the bush, her slender body jerk as she tried to run. Then the sword swept down. The two men ran after their comrades.

He did not remember clambering back into the ship.

"All right, Simon?" Manston asked, and then he saw his commander's face.

"All—right, Pete," Old said. He found it difficult to move his lips. "The library is

empty—at least, it will be when we move in. We should have plenty of time before that mob arrive.”

Manston did not ask what had happened inside. He said: “I suppose you saw those last two soldiers kill that girl?”

“Yes.” Old roused himself. “I gather you saw it from here? Well, it has no bearing on what we are here to do. Prepare to time-shift, please, Peter.”

“Yes, Simon.” Manston was subdued. Behind him Old could see Conrad. The lad’s face was green.

Somewhere in the vitals of the ship he heard a voice. “The swine impaled hundreds of people over on the other shore. Sat ’em on stakes and let ’em kill themselves——”

“Silence!” Old swung back to the control board and stood very still as Manston set the verniers, manipulated the dials and brought the ship into condition ready to time-shift.

“Make it right, Pete,” he

said in a low voice. “We can’t afford to make a mistake. It costs the Earth to move the ship as it is, and the Chief will have my bones for soup if we waste an ounce more of fuel than necessary.”

“Righto, Simon. I’ve got my eye on our expense sheet.”

Breaking the currents that had been swirling in the heated emotional atmosphere, Hardcastle’s nervy voice brought things back to the normal plane of everyday life.

“A great pity that it costs so much to travel in time,” the Ministry man said. “However, I believe that very shortly a new process may be completed which will allow excursion trips for those people who might wish to witness the events of the past. It may satisfy them more than the films so far shown.”

“They can have this little lot, for me,” growled Manston, and Old agreed fervently. He watched as the ship slid into that speckled, dun-

coloured unknown region of no-time, where they were moving through the days in a matter of minutes. When they had gone back again into the past for a time sufficient to give them plenty of clearance room, he ordered the ship to be moved into the library. Still invisible, it nosed its way across an open space where half-naked workmen toiled among brick and marble. They were building the library. The ship rested on the exact co-ordinates registered by Old on his instruments and they began the flight into the future again.

"Steady as she goes, Peter." Old was watching the big red hand that had been zeroed down to the time of arrival in the library just prior to the sack of the city. They could not have simply busted in without his preliminary reconnaissance—there might easily have been someone there, in the exact spot in which they intended to materialise. But as that was a direct negation of one of the basic laws of

matter, the result would have smeared portions of them, and the library, over the city. That was just a minor hazard of a Time Scanner's job.

As soon as they had materialised in the gloomy vaulting stuffiness of the library, with the thunder and rumble of the cannonade growling at them from outside, the crew jumped into the work of transference. Working from the films Old had shot when he had made his reconnaissance they ripped out volumes, replaced them with the prepared dummies, scrolls and books with heavy plastic bindings, aged to simulate the priceless leather and gold of the books destined for the hungry eyes of Wallenstein. "Make sure you take only the right ones," Old ordered Manston. "It wouldn't be clever for the Turks to try to read a blank book with plastic covers. And the litho printing of gibberish would create so many legends—hurry it up there!" he shouted as the men wavered at the crashing

din that had smashed in in a crescendo of noise. That must be the general assault breaking over the west wall, after the flank attack. At this very minute, out there in the dust and confusion, Giustiniani was being struck down, carried away helpless in agony, to his ship. History was on the turn. He shouted again to the lookout, posted to check and double-check that nothing occurred to upset their plan. Not that it could—hadn't he already seen what had happened? But Hardcastle was there, long face peering everywhere to see that the precise Ministry rules were not violated.

They could not have attempted to exchange the books before this—the library had been occupied until the moment of the first break in—and they were forced to use the tiny space left between that event and the sack and looting of the place. Old was sweating. He didn't want to have to return into the past and start the operation again,

on the second run transferring those books he hadn't been able to reach on the first. The Chief would flay him for wasting fuel and money. He checked his film copy.

"Over there——" pointing. "Make it fast; you've got thirty seconds before the Turks break in."

In that half minute the last of the books were bundled into the vast holds of the ship, mechanical handlers taking them as soon as they were passed inboard. The Ministry positively forbade mechanical handlers outside a ship; all work had to be performed by men attired in the dress of the age. Just in case some of them didn't get back, or were cut off—imagine a Medieval Turk confronted with an atomic-powered handler! The wooden trucks, genuine Medieval carts manufactured four thousand years in the future, were swung aboard. Two hundred men had moved something over 100,000 volumes, some very large and bulky, in a

time that should give the Chief a moment's pleasure. Old could spare not a second on thinking about what would happen; he had to concentrate on finalising this expedition, bringing it successfully back to the far distant future.

And then he saw the lithe form of Conrad, his Turk's chainmail gleaming in reflected fireglow, dart out the main door, disappear out onto the crowded bedlam of Constantinople.

"Conrad!" he yelled. That was a futile gesture. It annoyed him with its betrayal of his weakness. He did not even think that this was a typical result of Time Travelling, too great an empathy with the events and people of the past combining to break down the barriers of normal thought; he was busily computing the best method of patching up this catastrophe.

Hardcastle said: "If things are much the same when we get back, I'll have you broken for this, Old."

Old didn't bother to query

whether he wanted things the same or not. He shouted at Manston and as his second began to shift the ship in time, said: "Not future, past!"

Manston looked startled. Hardcastle began to protest. Old cut them both short with a furious oath.

"We can get the fool back!" he said shortly.

As the walls of the library blurred and vanished. Old saw the onrush of Turkish vandals come howling into the building. The dun expanse of no-time caught them. Manston looked a query.

"Take her back, Peter, shift out of the library, and bring her in to hang just outside, invisible. And handle her neat!"

"Aye, aye, sir." Manston lapsed momentarily into his Space Navy habit, so peremptory had been Old's order.

"It's a good job Conrad is the son of the money-bags," Old said with ferocious humour. "The Chief can charge him with the cost of this extra time-jump."

The fool had obviously decided to do something about the girl hiding in the bush. There was no other explanation of his conduct. He certainly wouldn't want to stay back here, stuck to life in this century, with its madness and bloodshed. And he'd know that Old would come back for him—that was the devil of it—he was the son of the big man. Old cursed.

They stopped moving in time, for a fleeting instant slipped into the flow of the normal space-time continuum and then, gliding outside the foundations of the building, began the journey back. Manston handled the ship superbly. They came to rest, coming back through time, to hang outside the library, watching the deserted street. Old had that familiar prickling sensation that came to him as he contemplated the fact that inside that building he was standing superintending the loading of the ship.

"Wait!" he said shortly, and, clad in Turkish chain

mail, slid to the ground and sped to the shelter of a grey wall. Worry gnawed at his mind. Ought he to have carried out a reconnaissance run first? He disposed of that idea. He knew that once Conrad got mixed up with the Turks, history would alter. It might not alter a very great deal; but the alteration might broaden out in time until the men aboard the ship, Manston, Old himself, might never have existed in the new time continuum. He might have hung the ship right outside the door so that Conrad would run into their arms; but the time interval was too short. The mass of barbarians coming in would engulf Conrad, make it impossible for him to be picked up. Old cursed everything and crouched in his tracks, waiting for the moment when Conrad would emerge.

He seemed to have been hearing that same swelling of noise all day. The guns and shrieks, the crash of falling masonry and the dervish wail

of attacking Muslims tore at his nerves. The Janissaries would be piling over the walls, walking on the dead masses of bashi-bazouks. Giustiniani would be being carried away now. Constantine was ready to ride into the melee, shouting brave and noble words, to be cut down and with his death bringing the fall of the city. Old waited through it. Turks ran up the streets; brands set fire to houses; people were screaming in fear and running helter-skelter for cover. He realised with a sick feeling of loss that he had not scouted the events here; he wasn't quite sure of what was to happen.

A mob of wild-eyed soldiers rushed into sight, heading for the library. From the east another mob came, a mob that shrieked and howled like hounds from hell. Old looked carefully at them, wondering why they should come from the opposite direction from the walls. Then he saw Conrad come out of the

building and look quickly about him. There was no sign of the girl.

Old decided to stay where he was until the looters had entered the library. He must keep Conrad under observation, ensure that he didn't do anything more to upset pre-ordained events—and Old knew that he would go a long way to make sure that events were pre-ordained in this case. His job depended on it. The rabble of Turks halted uncertainly and then, even in the instant that Old remembered this sequence on Bill Slazenger's stereos, were ridden into by a squad of Christian soldiers. The Turks from the walls shouted and rushed to their comrades' aid.

It was over very quickly. The knights hacked their way into the Turks who had come from inside the city, rode them down, and even Old was struck by the stupidity of the Mahomedans. They appeared totally incapable of handling their weapons. A few broke and

fled. Then the second batch of Turks crashed into the knights and the Christians turned to fight more of these delaying tactics elsewhere. Old knew that Giustiniani had ordered the inside gates of the walls locked so that his men should fight to the death; but there were bands fighting all over the city now, a result of the break through in many places.

The fiendish yells of the Turks broke out afresh and they swarmed into the library. Old had a sardonic moment of humour at the thought that all their burning would consume paper and print made four thousand years in the future.

Conrad had hidden himself in the bushes near where the girl would come to hide after the Turks had left the building.

Old decided to wait until the coast was clear and then to go over and take the boy by the scruff of the neck and frogmarch him back to the

ship. He was beginning to shake with anger now.

A Turk crawled through the dirt towards Old. He looked at the man, seeing the arm half-severed, the dragging legs, the anguished face, sweat-stained, gasping——

“Charlie Barnes!”

Old was horrified. He leaped out, caught Barnes’ body, drew him carefully under cover of the wall.

Barnes gasped and spat. He said: “What in hell are you doing here, Old? Time Dredgers have the licence on this job.” The anguished face contorted. “My arm,” Barnes said.

“Steady, boy.” No time now to worry about niceties. Old waved and made a signal to the empty air. The invisible ship would see them, realise that something was amiss. He had to make the ship come to him; he couldn’t move Barnes in the condition he was. And Conrad was safe for the moment.

Inside the ship Barnes, with

a hypno-shot dulling his wounds, could talk. "What about the rest of the Dredger men?"

Barnes groaned. "All killed. We planned to get into the library, barricade ourselves there, and help ourselves to the books at our leisure. They'd have been destroyed according to history. Anyway, the Ministry will have something to say to you Recovery sharks horning in on the deal."

Hardcastle said: "The Ministry has agreed this, Mister Barnes. Your attempt has been written off as a failure." He looked meaningfully at Old. "As will Mister Old's unless that foolish young man is saved."

"I'll see about him." Old's face was set and grim as he went outside again. Charlie Barnes' expedition had run into trouble ever since they'd had a fuse blow over the dome of St. Sophia—the glow on the dome that had been superstitiously referred to through history—and Barnes'

broken account told quite plainly why no sign of them had been seen in Bill Slazenger's stereos.

Old went across to the bush where Conrad had been hiding.

The lad was gone.

Old cursed. This was getting serious. So far, as he guessed, the lad had made no impact on history. When he did, Old wouldn't know about it. He might cease to exist, or he might become someone else, or he might do anything at all. Just anything.

Already flames were streaming out of the library and men came shouting out, scattering books, laughing insanely, burning, destroying. They were quickly tired of sheer destruction. They staggered off after more profitable booty.

Old decided he'd better stay by the bushes where the girl was hiding. She ran across from a burning house and, her face distraught and hair wild, hunkered down, hoping, as Old could sense,

that she would be unobserved in this trampled space where the battle had ebbed. He could not, for a million pounds, have prevented himself from looking at the tall library door. A flash of white appeared at the door, fluttered, and disappeared. That was him. He was standing over there by the door, watching the approaching Turks, and he was standing here under the wall, watching both himself and the approaching Turks.

A queer conception. Old still found it queer after his experiences in the Time Scanning business.

Then he saw Conrad. The youngster was rushing round the side wall, heading for the bushes. Before Old could straighten up, Conrad seized the girl, shut her outcry with one hand, and began to run towards his commander. Old stood up and shouted.

The Turks spotted them. Laughing, they shouted obscenities and rushed on, leav-

ing it to two of their number to deal with the girl. Conrad and Old were those two.

Old was shaking with anger and sweating with fear. Suppose the two Turks who had really killed this girl should now go on, and, because they hadn't delayed for that small moment, do something that would cause an upheaval in the time line? He waited, as his heart beat out a dozen strokes, for the catastrophe to break upon his head.

Nothing happened.

Conrad came running on, panting, his face grinning from ear to ear.

"Mister Conrad, I'll have your hide for this!" Old yelled. Smoke made them cough. Cannon and the crackling confusion of fire was all around the city. Constantinople was falling. An Empire was coming to an end. And Old gave Conrad an epic dressing down as they both ran for the ship. The girl was still over Conrad's shoulder.

Old said: "You'll have to take her back with you and I suppose you might even marry her—though I doubt it. One thing that's certain, you can't leave her here. She might have a child whose descendants killed Bonaparte. One of her great-great-grandchildren might put a wrench in the wrong place when the first ship goes off to the moon. Conrad, I could kill you!"

"I'll look after her, Mister Old," Conrad said. And Old could say nothing to the feeling in the boy's voice. They climbed up into the ship and Old said: "Take her home, Pete. And quick."

Through the centuries the ship moved, a marvel of science coasting through the ages, coming back at last to its own time, filled with the books of a lost age—and a young girl from that age, rudely snatched from death to the complex civilisation of an age so far beyond her comprehension that Old was filled with pity. Perhaps she might have been better off

dead—then he remembered Conrad's face, and altered that opinion.

The Chief was sitting in the chair behind his desk when Old went in and his lips were pursed up. Old grimaced.

"What d'you think Time Recovery is, Simon? A white slave outfit?"

"No, Chief," Old said, uncomfortably.

"Well," the Chief growled. "Tell me about it. Conrad tells me he wants to get married, that he wants you to give away the bride."

"He wants what?" Old was astounded.

"I've agreed," the Chief went on. "Only I do baulk at having a Constantinoplese—if that's the right word—for a daughter-in-law. And you're the only person who can give her away. After all, from what the brat tells me, you more or less brought her back."

"The whipper-snapper—sorry, Chief. I suppose I did. Anyway, after this, tell your boy that I don't expect any

more running after women when we go back into time. He's saddled himself with one—that should be enough.”

“I expect it will be.” The Chief smiled. “It was a good operation, Simon. Wallenstein is delighted with the books. He's given us some more work to do.”

Old pricked up his ears.

“I was kinda hoping that I could carry on that leave on Mars——”

“Sorry, Simon. Got a job for you.”

Old leaned back in the chair. He was in the Time Travel business, and time waited for no man. Even if you could jump about in it like a power-mad jumping-bean.

“Tell me, Chief,” he said resignedly.

“It's a simple one, this time. When the *Martian Queen* exploded on the way to Deimos, back in 2155, Harvey Langstrom Anglesy had just completed his greatest novel and the manuscript was lost——”

“Okay, Chief. I'll check with photo-planning. I need a holiday in space, and jumping aboard a spaceship that's due to explode is one way of spending it.” He smiled, feeling the old itch to get away into the vasty darkness of time.

“One thing about being in the Time Travel Business—time doesn't hang on your hands.”

NEXT MONTH'S ISSUE

THE CREEP, by Robert Presslie; other contributors include E. C. Tubb, Katherine Marcuse, Len Shaw, Frank Wilson, A. E. Roy, etc.

AUTHENTIC ————— A MONTHLY MUST

We don't believe in Martians. But if there are any, we may well need an expert in—

JOB ANALYSIS

BY JONATHAN BURKE

IT'S A THANKLESS JOB AT THE best of times. Back on Earth there was trouble enough. Here, there has never been anything else but trouble.

At least there weren't any freaks to cope with, back home. You knew what you were doing. When the results were analysed and the findings announced, everyone would howl that you *didn't* know what you were doing, but you got used to that. At least there were some standards. At least you were dealing with human beings.

"The fume conditions are deadly. I tell ya, this is the lousiest job in the plant. Ask anybody."

Ask anybody. The lousiest job in the plant was always the same—the one you happened to be investigating at any given moment.

"Guess this merits top grading, huh? You got to be

skilled to do this—years of training it takes . . . Ask the chargehand. He'll tell you."

Ask the chargehand, the foreman, the departmental chemist. Ask anybody. Ask everybody.

But they were human, all of them. You got to know their tricks. In time you got so that you felt disappointed if an operative didn't exaggerate the danger, the fume conditions, the manual effort required on his job, and all the rest of it. It was no fun when they were honest.

Because my job was a skilled one, too. The skill came in sorting out the truth from the magniloquent claims, the relevant from the circumlocutory. That was what I had been trained for. It was what I was paid for. I had to sniff poisonous fumes, nod over delicate gauges, and listen; and when I had listened,

I had to decide what had been worth hearing.

I am a job analyst.

It sounds good. It sounds nice and professional—something you can do without getting your hands dirty. But some days I got to smell worse than anyone else with a labouring job to do. Like when I was working in that sprawling, stinking chemical factory. Just to show I took the job seriously, I had to crawl inside stills, help to scrape muck out of a man-size condenser, and lean over effluent tanks until the stench got in my hair and stayed there for days.

And always there were the theme songs.

"You got to admit this is the filthiest job in the whole place—now, isn't it?"

"Only a skilled man can hold this job down. Top marks for skill on this process, ain't no doubt about that."

I made notes while they watched suspiciously, and when I was back in my office with the job grading charts spread out in front of me I tried to balance one assessment against another. Were

the fumes on this last process as irritating as those on the reactor I had been analysing yesterday? Maybe not. On the other hand, what about the dermatitis risk? (Check with the departmental chemist and the works medico.)

Punch the computer and brood over tables of figures.

When I had finished with the chemical plant, there was the atomic fuel plant at Cherry Flats to be dealt with. If you want your jobs graded, send for Martin Walters. He analyses anything. Graphs and wage tables while you wait. Bonus schemes to suit every pocket. Guaranteed to leave a trail of dissatisfaction wherever he goes . . . and still there's nobody else does it even half as well.

Maybe you think I'm boasting. Maybe I am. But I've good reason to be pleased with my record.

When they had the labour dispute in the spaceship construction plant at Pittsburg, they called me in. It was all a matter of the usual wage trouble, the usual Union disagreements. Everyone was

clamouring for danger money, supervisory money, responsibility allowance, exertion credits, and all the usual things. I spent a month learning the basic jargon of the workshops, never having been near a spaceship before; and then I got to work.

I split the grading card into ten categories, and in consultation with the various shop controllers I hammered out a points system for each category. Time needed to learn each process, skill required, attention to gauges and diagrams, amount of supervision normally exercised . . . at last they were all settled.

"Responsibility" was not easy to grade. The man who did a careless welding job could cause the death of a hundred people ten thousand miles out in space just as surely as a skilled instrument mechanic could do it by misplacing a terminal; but you couldn't grade the welder on a level with the instrument mech.

It was tough. But I got through it in the end, even though nobody loved me by

the time I was through. When the points in the various categories had been added up, analysed, and measured against the sliding wage scale, credits up to ten an hour were laid down for the men at the top.

Dissatisfaction? Sure there was dissatisfaction. Short of giving everyone in the place top marks and top pay, there was no way of avoiding the groans and accusations. In fact, to give everyone top pay would have been to raise even more hell.

In the end they always accepted my findings. And then some other firm would ask for my services. And each time, my fee went up. The lump sum went up, and the monthly retainer went up.

The biggest fee I ever asked was the one for this job here. And that wasn't just my biggest fee: it was my biggest mistake, too.

The man who had sent for me looked as though he knew his own mind. He also looked as though he wanted to persuade me that he knew mine.

"This is a job that's got

to be done," he said. "It's a job you'll want to do." He had started talking right away, and only now was he nodding me curtly towards a chair.

"Better give me some details," I said. Big talk means nothing to me.

"It's your duty to the community to tackle this one," he went on. "It's got to be handled properly—and quickly."

"I don't like to be rushed," I said.

"It's essential for the development of interplanetary trade. Essential for the whole future of the planets."

He sprawled back and looked at me as though beginning to have doubts about my capabilities. For a moment I was rattled. I told him what I had just done in the spaceship plant, and he nodded abstractedly. Then he said:

"Conditions are different on other planets."

"Other planets?" That made me wary. "Look, I don't know where or what this place is you're talking about—or, rather, haven't got round to talking about yet——"

"I am talking about Jordanstown."

"Where on earth——"

"Not on Earth," he rapped out. "It's the new industrial centre on Mars."

Of course it had to come. Sooner or later someone was bound to want me to go off into space. There were only just so many factories on Earth, and you could bet that their administrative troubles were nothing compared with the troubles there must be in the colonies.

I didn't like the idea. I'm used to every sort of factory and every sort of smell—my nose and stomach can take a lot of punishment; but I'm a rotten traveller. Helicars are bad enough, stratocars worse. The thought of a long trip in a spaceship did not appeal to me—particularly as I had so recently done the grading down at the construction plant, and knew the possibilities of error and breakdown.

I said: "It's a long way away."

"You'll be there a long time," said the man behind the desk. You would have

thought he was saying something warm and reassuring, something that made it worth while.

"I don't want to be away a long time," I said. "You get forgotten—lose your contacts. My reputation would suffer."

He snorted. "Look, Mr. Walters. You make a good job of this, and your reputation will be so big you'll be naming your own figure for any job you do from now till doomsday."

I thought there was no harm in taking him at his word and naming large figures right now. I thought of a number, doubled it, added the return fare to Mars, doubled the whole lot again, and told him.

He did not even blink.

"Agreed," he said.

One good thing about my job is that you learn not to look impressed, surprised, or even mildly interested. I just nodded casually, and asked him for details of the set-up at Jordanstown.

He had it all laid out on a visipad in front of him. He went through it point by point,

telling me all there was to tell.

It sounded the usual sort of thing, with the usual difficulties.

And one difficulty I had never encountered before.

"You'll find the worst snag," he said at the end, "is the question of local labour."

"Local labour? You mean Martians?"

"Martians," he said.

"I suppose the Unions——"

"The Unions are being very awkward. They know we can't get the work done without employing the natives, but at the same time they create awkwardness on every conceivable occasion."

"What are the natives like?" I asked.

I had seen travelogues on the video programmes, and the usual bleary illustrations on the morning newstapes, but I had somehow never got round to doing much solid thinking about Martians. I always had enough on my mind without that.

"Clever," he said, "and unreliable. Adaptable. But downright cussed."

"Just like human beings," I said.

Maybe the twitch of his mouth was meant to be a smile. He said: "Anyway, the Unions——"

"I've had plenty to do with Unions," I assured him. "There can't be any problems up there that I haven't encountered down here."

Which just shows that, in spite of the colossal fee I was getting for my expert services, I still had a lot to learn.

The Jordan Channel, the biggest of the Martian surface faults, was dry when I arrived. So was I. The Jordan Channel would fill up in two months' time. I filled up within an hour of arriving—Martian *telca* was the stuff, and very fine and refreshing it was when you got used to the initial flavour of resin.

The Interplanetary Construction and Development Company sprawled below the hills near Jordantown in a symmetrical yet unattractive pattern of sheds, domes and dwelling houses. The machine shops were enclosed in the

main dome, within which stable atmospheric conditions were guaranteed by pounding generators—more for the sake of the stuff that was made there than for the benefit of the workers. The houses huddled in groups under smaller domes. One of the research wings of the plant was working on projects designed to eliminate the domes and establish a breathable atmosphere which would be held in limits by a force-field. They had the thing perfectly lined up in theory, but the force-field wouldn't stay put yet.

The men who worked under even temperature, pressure and humidity inside the shops complained of the heat.

"You got to admit this is debilitating. That's what it is—debilitating. Ask anybody. Reck'n we qualify for top grading in this hell-hole."

The men out on the job in the desert, laying pipelines for the water supplies through and beyond Jordantown itself, had to work in space helmets. Through their throat transmitters they told me, in metallic voices, that it was

almost impossible to work under such conditions.

"It strains your neck muscles. Bad for the shoulders. Gives you a headache the whole durned time."

Then when the helmets broke, as they frequently did if one made a careless move, or fell over—which was easy in those odd gravitational conditions—the wearer had the discomfort of inhaling Martian air raw.

"Turns you blue," said one engineer. "Makes you go real blue."

He removed his helmet to demonstrate. His face was already puce-coloured, probably from prolonged over-indulgence in *telca*, and it was hard to tell whether there was any appreciable change. I made a note to check when I got back inside.

"And a long exposure," he added, "gives you Martian hysteria. It's deadly."

I made my notes, and reached a few tentative conclusions. Actually, it was true that working conditions inside the dome were arduous for human beings. But so were conditions outside. This

planet wasn't made for our people. Really, the sensible thing would have been to let the Martians do everything.

The sensible thing, come to that, would have been not to try and do anything at all on Mars. But it was no good putting that down as one of my findings.

A fortnight after reaching Jordanstown, I got round to the atmospheric stabilising plant, and it was in that humming heart of the place that I interviewed my first Martian.

Flimsy is the word for Martians. You feel that if you take a good blink and stare hard enough for long enough you'll be able to see right through them. Those willowy arms—all three of them—and the bodies so thin as to be almost two-dimensional, look as though any wind could twist them up and fling them away like fluttering curls of paper.

The flimsy appearance is deceptive. Just as the erratic workings of the Martian mind, apparently so scatterbrained, are deceptive.

I stood and watched one of them. It (there aren't any he's and she's on Mars, and if you want to know how they get along you can catch a video science programme some time) was standing there watching somebody else.

"This is the main purification chamber," said the chargehand who had brought me in. "Jackson, here"—he indicated the man the Martian was watching—"looks after the deglotting stage."

"Deglotting?" I queried.

"It's a term we use. It summarises three things. You'll find it in the handout the chemist gave you. Removal of Martian shards, upping moisture content, and concentrating so that you stabilise pressure. It's tricky."

"Sure is," said Jackson at once, although he had given no indication that he had been listening to us. "Trickiest job in the works. Trickiest on the whole planet. Top grading for skill and responsibility, if you ask me."

I asked him. The chargehand went away, and I asked the usual routine questions. Was he genuinely responsible

for control of the airflow, or was there a chargehand to check on his gauges? How precise did his timing have to be? What proportion of each shift could be spent in sitting back and taking it easy?

He demonstrated the procedure. Adjustment of flow from Stage 20A on the floor above, adjustment of the cooler, and then matching of pressures.

"To get the best results, you need to turn this knob right at the minute you let the stream through to next door there. An' on top of that you gotta keep an eye on these dials, or you might not notice an extra grit content. When it blows up a storm outside, the filters play some mighty funny tricks."

"Easy," said the Martian.

I started. "What was that?"

"Is easy," said the Martian.

"You stay outa this," said Jackson.

I said: "Just a minute. Is this man—er—Martian on the process with you?"

"He works under me," said Jackson. "I give the orders."

"So you have some super-

visory responsibilities?" I said, preparing to make a note.

He stuck out his lower lip. "Is that good or bad?"

"There's an extra points allowance for supervisory responsibilities," I said.

"Sure," said Jackson. "Sure I got supervision to do. He works under me."

He scowled without affection at the Martian. The Martian shrugged—a movement like some Balinese dance gone wrong—and reached suddenly forward. A knob twirled, two arms snaked swiftly over the small control panel, and there was a gentle humming noise through the sequence of narrow pipes.

Jackson said: "Who said you could . . . what in thunder d'ya think . . ."

"Was hold-up," said the Martian. "Would clog. I fixed."

Jackson studied the gauges. I got the impression that the Martian had somehow averted a minor fault, but that Jackson was not willing to admit this.

I found that I was beginning to cough.

So was Jackson. He scowled

again, and indicated two suits and helmets hung on the nearby wall.

"Knew it was comin'," he grumbled as we got into the suits. "Grit storm outside. Makes dreadful fumes in here."

"But it ought not to——"

"It ought not to," he said with relish, "but it does. That's the way of this durned planet."

"You can work all right with this equipment on?"

"It's ten times harder," he said in the helmet receiver, his voice moaning triumphantly down my ear. "Worst job in the whole plant."

I said: "What about the Martian, whatever his name is?"

I was watching the oddly graceful, fragile creature twisting about over the pulsing machinery. It did not seem to be incommoded, though I had the impression that it had changed colour.

"It's name's Brik. At least, that's the way we figure it. You have to boil down the noise it makes to somethin' reasonable, an' Brik's the nearest." Jackson's eyes

gleamed with dislike as his helmet swung towards the Martian. "It's all right for them. They can stand whatever happens on this lousy planet."

"That's going to be quite a factor in the job grading——"

"Martians don't count," said Jackson, "in this grading business."

That was only the beginning.

Anything an Earthman could do, a Martian could do better. Variations in the atmosphere and in working conditions made the Martians change colour, their scales running through a lovely spectrum from something you might roughly call cerise to something that was not unlike green if there had been such a colour as green on Mars; but nothing slowed down their work. They would watch an Earthman grappling with some complicated process, and within a few minutes they were able to take over and show him how it ought to be done.

I pointed out to Superintendent Murchison that in

every separate process on the plant the Martians would merit top pay.

He nodded sadly.

"You don't have to tell me. That's a problem we've been trying to figure out ever since we opened up here."

"How do they grasp everything so quickly?"

"They're telepathic," he said.

"You mean they can read our minds and learn how to——"

"No. They don't read *our* minds. Different wavelength, or something. No, they have a sort of mutual link—all Martians are tuned in to one another, so that when one has a problem the allied minds of all of them get to work on it. They all concentrate, and produce an answer, or a skill, a technique . . ."

"But that's wonderful," I said.

"Not so wonderful," he said. "They're too clever for the liking of the Union craftsmen——"

"Why do we always have this trouble with the Unions?" It had been getting me mad

over the last week, and I was ready to let fly at somebody. "Restrictive practices, obstruction, downright cussedness—never anything but trouble. No pride, no ambition, no belief in their own craft."

"That's the way it is," he agreed, glancing over his shoulder to make sure there was no Union representative sitting in the corner taking down notes for the next Management Committee meeting.

"If you can depend on the Martians to do a better job——"

"But you can't," he said. "That's another trouble. From the men's point of view they're too clever by half. From the administration point of view, they're too erratic."

I had heard that word used about them before. I wanted to know what it meant.

"That concentration of theirs is all very well," said Murchison. "It helps one member of their group each time their minds go into a huddle. But the other members, in order to concentrate, have to withdraw their atten-

tion from the jobs *they* are supposed to be doing."

I saw the point. I saw it even more clearly during the next few days, when I did a bit of concentrating myself—concentrating on the Martians and trying to evolve some way of fitting them into the whole analysis scheme.

You could give a tricky bit of work to a Martian, and he would do it in half the time an Earthman took to do it. But if you went away and left him to get on with it, you might return ten minutes later to find him wavering dreamily over the bench in a sort of suspended animation—his mind had been called away to wrestle with the problems of a colleague on the far side of Jordanstown, and the building could catch fire before he would reluctantly come home to his own consciousness.

Clever, yes; and erratic.

But that did not alter the fact that whenever I was engaged on the grading of specific jobs, I had to give the scaly workers top marks.

I tried to talk it over with one of the foremen.

"Look," I said in despair. "I've never had to go in for philosophy in my profession before, but I'm getting close to it now. What is the ethical solution of all this?"

"Huh?" he said helpfully.

"If I give the reactor operative top classification for fume conditions, dangerous work, and responsibility—considering how many people's lives depend on the purification plant, he's bound to get that—how do I assess his Martian mate? On the basis of figures alone, he gets the same rate for the job."

"The Unions wouldn't stand for that," said the foreman.

"And in a way they'd be right," I had to admit. "Because, although the conditions are the same for the Martian, the Martian doesn't *feel* them the same. Heat and poisonous effluents don't affect it. So you could say it can be paid at a lower rate simply because it's immune to the things that merit danger money or dirt money for a human being."

"The Unions wouldn't stand for that, either," said the foreman, joyfully pessimistic. "Because that would

be encouraging cheap labour and lowering the Union standards."

I said: "I give up."

Of course I did no such thing. Martin Walters never gives up.

Martin Walters is a mug.

I knew I could have arranged something if it had not been for those pestilential Unions. I could have blinded the management with figures. Given the opportunity to take individual workers, or even groups of workers, on one side, I could have explained the whole set-up to them in such a way as to leave them satisfied. Or baffled, anyway. Often enough it's the same thing.

But not with shop stewards and Union malcontents stubbornly bringing up bleak generalisations. The rate for the job . . . maintenance of labour standards . . . All the usual jargon. And behind it, the main cause of it all, the instinctive resentment of alien beings—the conviction that Martians were inferior and had got to stay that way.

I began to believe in dictatorship. I began to yearn

for the good old days of capitalist exploitation, grinding the faces of the workers in the dust (spiky, poisonous Martian dust for preference), and for the outlawing of Unions.

It was a sweet daydream; but it didn't get the job done.

I realised at the end of two months, after interviewing five hundred operatives and making my preliminary breakdown of the process departments concerned, that the whole thing was going to take longer than I had estimated.

I needed more time.

And more money.

Armed with papers and a slide-rule, I went to see the Superintendent and his heads of departments.

The office at the top of the tower was austere by Earthly standards, but sumptuous according to Martian reckoning. The furniture had been made by Martian craftsmen to Earthly specification, and although there was something odd about it—Martians did not sit down on the same part of their anatomy as we did,

and found it hard to adapt their plans to our requirements—it was, nevertheless, rather striking.

Diffused light falling through the anti-glare windows gave the room a mellow appearance. You felt that you had been lifted out of the turmoil and petty disputes of the workshops, into an atmosphere of good fellowship and soothing wisdom.

Murchison said: "Make yourself comfortable, Mr. Walters."

I sank sideways into a chair, and spread my papers on the small table beside me.

"I've come to report on progress," I said.

Murchison nodded. Two of his colleagues smiled. Maybe their smiles were meant to be reassuring, but I thought there was something odd about them.

I said: "I have completed preliminary analysis of the following sections." Then I reeled off the names of the departments and various local groups which I had visited.

While I spoke I noticed that Murchison was reading down a list that lay on the

table before him, as though checking each section as I named it. It put me off for a moment or two. He could hardly be verifying what I was saying, because he had no copy—this rough draft was for my own use only, and I had not yet submitted any formal report to the management.

When I had finished, he said: "Yes, yes." Again it was as though it had all worked out as he had expected.

I wondered if he had been keeping watch on me as I went round. There seemed to be no point in that. If that had been his game, I was all set to be annoyed about it.

"Now," I said curtly, "we come to those points awards which I think will serve as a basis for the final assessment."

I looked up from my visipad, with its neatly tabulated results, and found them all staring at me with that queer deadpan expression I had noticed before. It gave me prickly heat all the way down my spine.

I got aggressive. I said: "Before I go any further,

there's one thing I'd better make clear. This analysis is going to take longer than I expected. Nobody back on Earth gave me to understand the full scope of the problems involved."

"Nobody back on Earth has the faintest idea," said one of the departmental heads sourly.

"Also," I went on, "in view of the hostility which is shown to me, and the difficult conditions in which I have to work, I must ask that the extension of time I spend here shall be paid for at a double rate. If you want my continued services, gentlemen, you'll have to pay for them."

There wasn't a flicker. Not one. Or maybe one of them smiled—and if that was a smile, it was not pretty.

Murchison slowly said: "I'm not sure that we *do* want your services any more, Mr. Walters."

Outside a hooter went off. Inside, I nearly went off.

"I don't get you," I said.

Murchison drew the sheet that lay before him a little closer, and prodded it with his forefinger. It might have

been an indictment, the way he was eyeing it.

He said: "Shall I tell you what your points awards are for the jobs you've graded so far?"

I glanced automatically down at my own figures. They had only been worked in detail during the last twenty four hours.

"If you've got some clever spy system——"

"Not a spy system, Mr. Walters," said Murchison. "Just some adaptable and enthusiastic employees."

"I still don't get it," I said.

He began, in his smooth, derisive voice, to read out the figures for various operatives in different departments. I looked at my own list. The figures tallied every time. Once I tried to interrupt, but he gently waved one hand and continued down the column.

Not a mistake.

At last I got my mouth properly open. I said: "You've been tampering with my documents. But I don't see what's so clever about that."

"We have tampered with nothing. I can, in fact, go on

to give you gradings that you have not yet done."

"Now wait a minute——"

"Furthermore, we have a solution to the antagonism between Martians and Earthmen over the wage question."

That stopped me. "Tell me," I said. And I meant it.

"It appears," said Murchison, "that the Martians have only just realised what all the fuss is about. And in presenting us with these tables——"

"The *Martians* presented you with them?"

"They did, indeed. They have been studying you with great interest, and when they understood what you were assessing and what general principles your questions followed, they went into their usual mental huddle and worked out a complete grading scheme in a very short time. The way in which the two sets of results coincide is a testimony to your accuracy, Mr. Walters—or to the accuracy of the Martians' testimony, whichever way you care to look at it."

"I don't care to look at it any way at all," I said. "It's

unethical. It's not professional etiquette." And then I said: "And what about the business about the Martians and Earthmen? What's the answer they've dreamed up for that?"

"Simply that they don't want to be paid."

"What?"

"Martians take very little pleasure in amassing credits and spending them in our stores. It means nothing to them. What they want us to do is dig for querdles."

"Querdles?" I was reduced to the status of a feeble echo.

"A very succulent and health-giving Martian vegetable which grows beneath the surface, usually under some rocky shield, so that the Martians can't get at it. They can't dig, you know, and they bruise easily. But they dote on querdles."

"But, damn it," I protested, "I didn't *know* that. If I'd known——"

"None of us knew," said Murchison affably. "But we know now. We supply the Martians with querdles—which we can carve out easily with our machinery—and we pay the Earthmen in credits.

Everybody's happy. And as the Martians have analysed the whole labour force in the plant, and made a very just and equitable job of it, we won't be needing to detain you any longer, Mr. Walters."

They're not going to get away with it, of course. That's one thing you can bet on. I'm not standing for that sort of treatment.

The idea of a gang of slimy Martians setting up to do my highly skilled work . . . and doing it on the cheap, too. No. There's going to be trouble about this. I know the professional regulations, and I know my rights.

I've got a Union. I'm a paid-up member of the Association of Time and Motion Analysts and the Affiliated Grading Engineers, and my Union won't stand for practices of that sort. We don't want Martians muscling in on our territory, and we won't countenance cheap work.

It's at times like this that Unionists have to stand together.

You could offer him the universe, but what he wanted was—

Just One Way Home

by ANTHONY G. WILLIAMSON

THE OFFICE WAS HOT, fly-blown and reeking with stale tobacco smoke. Mike Forster went in slowly to face the fat sweating man behind the desk. Awkwardly he stood waiting, his weak blue eyes flitting round the room, afraid to rest on the indifferent bulk of the man before him.

"Want to see me?" the man rasped harshly, looking up from scraping dirt out of his fingernails.

"Yes, I want a job," Mike Forster said quickly.

"You're Forster!" It was a statement, vaguely disparaging.

"Yes, how about it?"

"You're no good to me, fella. I want fit men." He went back to cleaning his nails, working silently with a

sliver of match whittled sharp by the open clasp-knife beside him on the desk.

"I can take anything you got," he said meekly. "Only want a chance to get off this hell-hole of a planet."

"You made a mess of a PX4 last year," said the man, not bothering to look up. "That was your chance, fella!"

"It wasn't my fault the tubes failed on me. What can a man do? You've got to help me get a job. I've been lying in a stinking hospital for six months and I've got a wife and kid back on Earth!"

"Yeh, yeh!" He glanced up momentarily, eyes hard and uninterested. "So have half the other bums round here. Why do you come out here if you've got someone at home? You think you're going

to make your fortune, every planet a goldmine all open and waiting for you . . . Look at you now; your wife wouldn't give you a second glance!"

Mike licked dry lips, the blood tinging his sallow cheeks. "There isn't anything wrong with me that the sound of tubes firing can't put right."

"That sounds real nice, but suppose it didn't go right. You'd sit right back on the blast pan and we'd all get singed up just because you thought you'd licked the fear that made you smash the last one!"

"It's not like that, I promise," he pleaded fervently. "You got to help me! Back home there's the cutest little girl you ever saw waiting for me, and there's a kid, too. Must be near three years old now and I've never seen it. For two years I did pretty good; you must have heard about me then. Did most of the outer solar runs, made quite a packet of money, too. Then they let me take that PX4 up without a prelim on the tubes . . ."

He was picking at his nails again, squinting at the black

dirt on the matchstick and sweating in the hot mid-day.

"Now all the money's gone on hospital fees," he continued bitterly. "The insurance men crawled out of it because there was no check sheet to prove the ship had been passed for take-off. It's not far, you could give me a ship and I'd be home in two weeks, and Jenny would be there, and I'd never leave again, and . . ."

"Okay, okay!" he said harshly, flicking the match away and mopping his face with a dirty handkerchief. "Cut the sob-stuff. I've heard it all before. See out there, on the strip?"

He pointed a finger vaguely out at the dazzling white lanes of the field with its blackened blast pans dark and strangely ominous beneath the warm breath of sun. Dust clouds whirled lazily in the air, the sky a deep violet blue with the sun a red dripping cup of heat that could wither the skin into brown parchment dryness. A rusted pencil of steel was pointing drunkenly at the sky.

"You mean the chemical

float?" he asked, face suddenly stiff and afraid.

"I don't mean no AH Express! That crate is all filled up with uranium ore for Earth. You can take it if you feel so bad about getting home!"

"But it's been obsolete for ten years!" he exclaimed weakly. "I'd never get it off the ground!"

"The guy who could take anything up if he had the chance!" the man jeered sarcastically. "Get going, fella, I'm a busy man."

"It would never get cleared by the authorities," he continued, eyes glancing wildly from the sweating face and hard grey eyes to the pointing finger outside. A finger that pointed mockingly towards home. "The insurance firms wouldn't cover it. How about that? How you going to get it cleared even if I did decide to take it up?"

"Look fella," his face was impassive as he fished out a cigarette and stuck it in the corner of his mouth, "get wise. That ship isn't insured, neither is the cargo, but it'll

take off either today or tomorrow, or next week. It makes no difference to me who takes it up, but you can be sure of one thing—everyone who matters will close his eyes when it goes. Understand? It's a sort of arrangement we have occasionally; you don't need to worry about it."

"I see," he said, the sweat cold and clammy on his forehead. "You don't care about the risk as long as you get your precious cargo off, is that it?"

"You want the job or don't you?"

He hadn't wanted anything like this. He'd hoped for second pilot on a big freighter, perhaps a single on a mail can, but not that tin coffin out there.

The room was filled with the bitter tang of Martian dust, the air was hot with a dryness that irritated the skin and brought the nerve jangling itch they called "dust rash." The fat man behind the desk was leaning back with closed eyes, the cigarette drooping in his mouth with its tail of blue-grey smoke.

"Okay," he said hoarsely, "give me the papers and let me get to hell out of here!"

He opened his eyes briefly, groped into a drawer and pulled out a board which had a sheaf of white papers pinned to it. Detaching a couple he flung them at him disdainfully. "You don't need immigration; just walk out and climb in. No one will bother you, and you can blast off as soon as you feel the urge, but make damned sure you hit that button hard 'cause she isn't as finely tuned as she used to be. Get plenty of height so that if you do fall back it won't be on top of this office!"

"Thanks," he said dryly. "How about when I get there?"

"Go into an unloading orbit and our company ship will come up and take off the cargo. They'll take you down with them and you'll probably get paid when you clear from Terra Central. That's if you get there . . . !"

"Look," Mike said bitterly, leaning over the desk to gaze at the man with bleak eyes. "I'm getting good and sick

of your clever little jokes! Okay, I take the ship out, so cut out the wisecracks and get things rolling so I can get out of this dump before sunset!"

"Get off my desk before I kick you out, you bum!" The man said the words harshly, blowing cigarette smoke into his eyes and staring coldly with mouth suddenly thin and cruel.

His glance wavered and nervously he drew back, waiting.

"You've got your instructions; there's nothing more to say. You'll be all right if you get away from here."

"How about the cargo?" he asked, trying to regain the brief spark of self-confidence. "That'll have to be checked, surely? And there's the servicing schedule . . ."

"Look," he wasn't interested in him any more, "the ship's out there, fueled and ready to go. You just walk out of this office, climb in, blast off and that's all there is to it. I've told you, the authorities will be looking the other way."

"How do I know the cargo's what you say?"

He didn't answer, just sat there looking at him with a faint tinge of contempt on his fat sweating face. When he took the cigarette from his mouth its end was wet and darkly stained. He looked at it for a moment, thoughtfully. Outside a sandcar went droning past, its engine mixing with the hot lazy day to fade away into the empty reaches of red desert and black rock.

Mike looked away from the man, hating the weakness in himself that made the sickening plunge of fear rise up in his stomach. He knew they didn't care about him, nobody did. If he fell back they'd only be bothered about the broken ship, not his body that would be all that remained of a vibrant dream.

Beyond the mountains the city lay, although he couldn't see it from the office. It would be still now, white and sleepy in the mid-day heat until the cold night came down to turn on the lights and let the streets glow warmly beneath the protective dome

that kept out the dust and thin dry air.

Mars! How he hated it! He spat disgustedly on the floor, remembering past months of loneliness and regret. How he hated the life! For a brief moment the old anger and strength came back as he thought of the city, so white and pure in the sun, such a cavern of vice and evil at night. The streets paved with the dreamers and the drunks, the tramps and the beggars; the women who laughed at the hunger of men, only their laughter was of welcome and their faces were greedy for the money that filled the city.

Money, he thought, what was money? He'd had plenty, yet it had all gone on drink and hospital bills. What of all the other frontier cities, wallowing in the rich fruits of worlds untouched and laden with mineral wealth? What good did it do the men who came and spent their lives collecting it, never going home until it was too late, and they were too old to enjoy the spending of their labour?

He'd seen it all. The men, young and filled with dreams that slowly withered and became ridden with the grime of evil cities, and harder men who could only think in terms of profit. It had only been three years, but by God he'd seen it all! He'd seen the women come out to stand at the streets and watch the money walk by until their faces had changed and they were walking in the streets with the money.

He remembered Jenson; he'd taken a base job on Venus. He'd saved up all his cash for almost two years, finally having the price of his girl's ticket out from Earth. She'd arrived, fresh, pretty, lovely as a wild flower with the breath of clean woodlands and green fields in hair and eyes. She'd stayed for three days in his bleak metal hut, the one he'd scrimped and saved to buy and never allowed himself to furnish well because he put all his money away for her, and on the fourth day she'd gone into town and taken over a five-roomed flat with all the

fittings, and a sign that said "come in" over the door.

He'd gone to plead with her, trying to make her understand that it wouldn't do her any good, that in the end she'd have paid much more than she ever got out of it. But there had been a feller in her room and they'd had a fight; the girl was killed and Jenson cried all night. The law had said it was an accident. Jenson still worked at the base, but his hair was white as snow and his eyes were never quite right.

He turned back to the man at the desk, wanting to throw the papers in his face. But Jenny was waiting home on Earth and there was a baby nearly three years old. This might be his last chance. "All right," he said. "All right, I'll take your blasted ship up!"

The man just smiled and watched as he walked out across the bright red sand and white ribbons of concrete that linked up the blast pans, darkly stained by ships long gone.

The ship was sitting uncertainly on the gleaming cone of the booster, its hull scarred and ravaged by years in space and chemical powered landings that never did work out right. He climbed the long tube ladder, pulling his bundle of belongings up and trying not to feel the sharp pains from the weakness in his chest. Panting, he finally struggled inside, closing the door and feeling slightly better as the motors pumped canned air into the control room.

There was a cushioned bucket-seat before a thin metal panel that held the banks of instruments and food lockers. The floor was dusty metal grating, the hull double thickness but showing the passage of years in brown rust and yellow fatigue patches that looked as though a sneeze would blow them off. It was quiet and cold, the blue lights soothing after the red glare of the sun.

Settling himself in the seat he checked fuel, air, food, instruments, before making the entry in the log. There wasn't much to do before blasting off, not in these

prehistoric deathtraps. He thought back to the gleaming darts of the old days, with a crew of four and the take-off ceremony in the ship's airlock. There'd be laughter and cheerful farewells, backslapping and the buoyant expectancy of a quick surge away to some new planet with the stars and the darkness a friendly enemy that could be tolerated without the qualms of fear.

It wasn't like that now though, not in this cold metal room with the rusted walls and quiet hiss of the ventilators. He was afraid. He was so afraid he had to sit for a long time and stare back at the mocking faces of the instruments before he could move his hand to press the button that began to heat the tubes for the initial blast of the booster.

Above the control panel there were some pictures of scantily clad girls, their laughing faces looking down at him and somehow comforting. There was one who was slim and fair-haired, her eyes brown and gently smiling with the curve of full red lips. She

was like Jenny. He looked at her for a long time, feeling the hunger and poignant longing that in the past had never been quite strong enough to call him back. He wondered if she would still be waiting, loving him with the tender understanding that had sent him foolishly away from the fresh green of England and the old grey church on the hill where they had rung the happy bells that Saturday afternoon so very long ago.

He could only hope. That was all that was left now, hope and bitter hatred at the cruelty of space. It had only been three years, but they had been hard years and they showed in wrinkled face, in thinness of body and weak blue eyes.

A green light flickered into life to bring the fear trembling back. Dry-mouthed, he reached out a hand and pushed over the switches, fastening himself tightly into the seat as the ship rumbled and tottered on a rising cloud of fire. The light changed to red and he punched, gasping with the

sickening fear, at the rows of switches before him.

The rumble changed to a savage roar, the hull creaked and groaned with its burden, and then there was only the fierce hand of gravity clawing him down into the seat and pulling the blood through his veins as heart strove madly to meet the challenge. The lights flickered, the gyros hummed and the seat sank right back into its springs as the fingers on the dials slowly moved across.

It was too late now. The ground was falling away and there could be no turning back. Alone in the echoing room he tried to push out the fear, the memory of the last take-off and the horrible falling back to pain and noise. Suppose it was like that this time? Suppose the motors failed again? This was his last chance and death was waiting outside the creaking hull, around the spouting pillar of flame that lunged out beneath them.

The sweat oozed out on his face when the booster gave out. He punched at the

ejection lever, hand poised above the switches that would start the main motors and take him away from all the lonely misery of the planet below. The light that said the booster was still with him remained on. He gazed at it numbly, his stomach falling in like the sides of an empty sack. He pushed the lever over again.

"You swine!" he sobbed, slapping at the switch and cursing the man who had sent him in this ship. "You filthy, murdering swine!"

Weakly he sank back in his seat and gazed with wide-eyed fear at the glowing light. The gyros were screaming as they strove to keep the ship on even keel, but their's was a futile fight. With the booster still attached to the ship he daren't fire the motors; the back-blast would probably detonate the fuel chambers and scatter them halfway across the planet . . . or blow off the booster.

He thought about that, trying to feel the courage and quickness of decision that had been with him in the old

days. Could he do that? Could he press a button that would almost certainly send him to his death? There was no one to help him, only the fear that clutched his insides. Sobbing, he fell forward on the controls, whimpering like a frightened child.

Above the red plains of Mars the ship poised uncertainly, set against the dark violet sky like some silver needle. Only now it was lost and leaning over to look down at the beckoning sand. In the distance the city gleamed white and innocently unaware of tragedy in the bucket-seat of a silent ship.

He raised his head from his hands, swallowing the tightness of throat. Above the panel the girls laughed down at him, and Jenny was there with her fair hair and brown eyes. Looking up at her he wondered how it had ever come to this. How he could be sitting in a steel coffin with no one to wonder or care, and Jenny up there looking down from where she had always been since he had left the peacefulness of England. "Out of reach and

yet near with the bond of past memories."

The ship shuddered and began to heel sharply over, about to make her last quick plunge from the sky. Suddenly he straightened in his seat, realising that Jenny had been smiling at him all this time and he'd never once thought of fear or death. What difference did it make? Hell, he died one way or the other, and at least he'd have the comfort of knowing he went out like the man who used to be called Mike Forster. He punched the switch that would erupt the mighty engines into life.

The blast of power surged through the silence of the ship in a wave of sound that made him close his eyes and wait for the end. But there was no hot knife to take him away, only a sudden quick pressure of acceleration. Opening his eyes he gazed at the instruments in disbelief, seeing the dead light of the booster

and the little fingers of the dials as they moved across to point the way to freedom, home, happiness . . .

With the gyros working full strength to correct the list of the ship, he lay back in his seat and looked up at the girl above the panel, and now she seemed to be smiling with just the faintest tinge of relief. Soon, very soon, they would be together.

At the office door the fat man flicked away the sliver of match and wiped his hands on the dirty handkerchief. In the sky a pin-point of light was fast disappearing into the darkness of space. Over the horizon a yellow star was beginning to glimmer through the thin atmosphere. He glanced at the vanishing ship, at the winking star, and smiled a contemptuous smile.

"Crazy guy," he murmured to himself. "Crazy, fluky guy . . ."

Venus for Never

by E. C. TUBB

MOST OF THE TIME I HATE the sordid, never-ending lust for money which seems to dominate almost everyone I meet. There is something slightly immoral in the spectacle of everyone in the universe grabbing with both hands at any credit note in sight. Men and women will do the most incredible things for tokens which, when you come down to it, aren't worth the paper they're printed on.

The trouble is that you can't live without them.

I was thinking about money from the moment I landed on Venus. Funny place, Venus. For a long time people thought that it was a jungle-planet, then science did some more speculating and turned it into a dust-bowl with a formaldehyde atmosphere.

Finally they got round to actually visiting the place and found it somewhere in between. The reason is the crazy set-up of the cloud layers, that and the winds. Anyway, there is a region of breathable air close to the surface and a fair-sized farming community has been established in the centre of the main continent.

So much for Venus.

I wasn't thinking about science as I waited my turn to enter the immigration shed. I was thinking about food, lots of food, and I could hardly wait as the officer stamped my passport and handed it back to me with a polite smile.

"You've arrived in good time, Mr. Dribble," he said. "It's market day."

"Call me Dusty," I said. It always pays to be on a friendly footing with the local authorities. "Market day?"

"That's right. Very interesting it is, too. Next please?"

I took the hint and passed out of the shed. I wasn't troubled with luggage problems. My suitcase held all that I considered essential, and, after spending some of my shrinking capital on a meal, I hired a room, dropped the bag, and had a look at the market.

I was never so disappointed in my life.

I'm not one of these smart-aleck city-types who sneer at the yokels. The yokels have proved themselves to be other than dumb by the money they manage to hang onto, but even at that I couldn't get interested in the buying and sale of livestock. I wandered around for a long time trying to find something familiar, a demonstrator selling the old standbys such as De-Fumers, Hydratic Dusters, Wonder Polish, Miracle Sharpeners, Insect Killers and Sonic Protectors, but I couldn't see a single one.

True, there was one old boy dressed up in a dirty sheet with a towel wrapped around his head who was selling lucky charms and fortunes. Trying to sell them, rather, and he looked as miserable as a rocket pilot whose ship is heading into the Sun. I stopped before him and gave him a credit for good luck.

"Aye, Sahib," he whined. "May the Gods of the East smile upon you and yours. Here I have a rare charm compounded of exotic spices and dried mummy from the tombs of the long-dead. For ten credits . . ."

"Stow it," I said, rudely. "I'm no sucker. What's the pitch around here?"

"Lousy." His whine dropped from him as he reverted to type. "These hicks hang onto their money as if it were glued to them."

"No good, eh?" I glanced around the market and I could see what the old boy meant. The natives were here for business, not pleasure, and they went about it as though their lives depended on it. How could I tell? Simple.

Few women and no children. The women and children are always to be found in a decent market, that is one where they have a little spare money to spend, but this collection of bearded farmers looked as though they had their pockets sewed really tight.

Well, almost.

I wandered around a little longer then stopped close to a man who sat behind a small table. That man was busy. A line of farmers stretched away from the table, all of them with a crate, and as each one reached the table he opened the crate and passed out what seemed to be balls of fluff.

The man—he was an old, withered, bald-headed man with a face like a prune—picked up the balls, looked at them, and dropped them into one of two containers. When he had finished the farmer picked up the two containers, put them into his crate and reached for his money.

My eyes bulged as I saw the amount passed across the table.

It took me a while to discover that the balls of fluff

were alive. It took me a little while longer to guess what the old man was doing. It took me no time at all to decide that this was one racket I just had to get into. I waited until he had a slack period and then smiled down at him.

"Busy?"

"Always busy on market days." Automatically he thrust his last take into his pocket. He had trouble getting the notes in, his pocket was so full. I forced myself to look away from that wonderful sight.

"I've been looking around," I said. "You don't seem to have any competition."

"Nope." He grinned and showed me his new dentures. "Took me twenty years to learn how to sex a Gru. Reckon it's about time those years began to pay off." He slapped his pocket and grinned again.

I nodded. At a hundred credits a time the old crow was making it hand over fist. I hung around for a while longer and did my best to get him interested in a partner,

but Abe (that was his name) didn't want to know. I used all the arguments, too, told him that he deserved a rest, that he could work faster if he had someone to collect the money, even hinted that a strong combination might be able to jack the price but all he did was to sit there and grin and shake his head.

But I wouldn't admit defeat.

Not with a gold-mine at my finger-tips, and my knowledge of human psychology. And it wasn't going to take me twenty years of training, either.

First I bought a length of thin, nylon string and cut it into sections about a foot long. Then I purchased the entire stock of lucky charms from the phoney Indian. I could have used anything, but they were the right size, the right shape, and looked a lot better than they actually were. Also—and this was important—they were slightly radioactive. Nothing in that, of course, everything ferried by rocket gets that way, but a lot of people don't know that, and they still think that anything which can make a

geiger click is something special.

Next market day—they had one a week—found me all ready to do business.

I set up a small table and on it I placed a cardboard box full of my stock-in-trade. I didn't shout, or yell, or do anything to attract custom. Instead, I merely sat down and, resting my elbow on the table, held one end of a piece of nylon string. At the other I'd fastened one of the charms and I just sat there, letting it hang at the end of its string.

Naturally, I attracted a crowd.

I say naturally because I'd sized up the populace and knew just what not to do. Shouting and noise would have frightened them off, but they were attracted by the spectacle of a man sitting alone playing with a piece of string with a weight on one end.

Recognise it?

That's right. The oldest parlour game there is. The old sex-indicator. Years ago they used to play it with cotton and a wedding ring,

but neither is essential, and my product looked much better than any such crudity. Basically it is simple. You suspend the weight over a male or female and it will either swing in a line or make a circle according to the sex of the subject. What really happens, of course, is that the operator controls the movement by thinking hard on line or circle. Involuntary muscular reaction does the rest.

I looked up at the bearded faces surrounding me and went into my demonstration.

I spoke slowly, quietly, almost with a sob in my voice, and sincerity oozed out of every pore. I was sincere, too. Another two weeks and I'd be searching the garbage cans for my next meal.

"Gentlemen," I said. "Allow me to introduce you to the latest marvel of modern science. Suspended from this special cord I have what is probably the smallest and most efficient engine yet devised. Powered by the atom and capable of assessing the different radiation emitted

by the male and female organism, it will register without fail the sex of any living creature over which it is suspended." I broke off the patter and gave them a dem. I held it over my hand, thought hard of a line, and, sure enough, the little charm began swinging pendulum-wise over my hand.

The crowd hunched closer.

I gave them some more talk. I stressed the radioactivity and offered to let them test it. I demonstrated on a couple of kittens I'd borrowed from the hotel, I could tell the sex of those, and then I called for a volunteer to make his own test.

They fidgeted, shuffled, then a burly man with arms as thick as trees stepped forward.

"Take one end of the thread, sir," I instructed. "Firmly but lightly, that's it. Now, sir, remember. A line for a male and a circle for a female. Now, what do you wish to test?"

Grus, naturally. I'd known that from the first moment, but I'd been very careful not to mention that at all. I'd asked about the Grus and everyone

assured me that it was impossible to tell their sex in less than two months from hatching. Then something triggered their glands and they betrayed full sexual characteristics. Only an expert like old prune-face could tell male from female earlier than that.

I waited while the farmer made his test.

He carried the usual crate and he dived into it and produced a ball of fluff. He suspended the indicator over it and everyone held their breath until the little weight began to move in a widening circle. Female! The sound of their exhalation was music to my ears.

He tried again with the same result. A third try produced a male, a fourth female, a fifth male again. He straightened with a pleased grin.

"It works! By cracky, it works just like he said!"

Of course it worked. The character already knew the sex of his Grus and so, unconsciously, he had directed the swinging of the pendulum.

I got in quick while they were still impressed.

My price was one hundred credits and I'd given it a lot of thought. One hundred credits was the price old Abe charged to sex each Gru. If they paid that for my indicator they could sex as many Grus as they wanted to and would save thousands. They thought that, too, and I was kept busy passing out the indicators and pocketing the cash. As they had cost me about two credits each, counting expenses, I felt that I was doing all right.

I was, too.

I couldn't sell them fast enough. I ran out of charms and had to sit up half the night making more. In between making and selling the indicators I was kept full-time counting my money and changing it into larger bills. I hate a lot of bulk when I'm travelling. In my spare time I had some fun going out of my way to meet old Abe and grinning at him. I did this for a reason. Not because I wanted to crow over him but because I was hoping

that he'd offer to buy me out. Sooner or later I was going to saturate the market and, when every farmer and his dog had a couple of the indicators, my business would be finished. I wanted to sell out before that happened but, to my surprise, old Abe didn't seem upset at all. He just grinned straight back at me as though someone had told him the joke of the century.

I found out why about two months after I'd first started business.

A man staggered into the market place and everyone turned to look at him. He was worth looking at. His clothes were almost ripped from his back, he was covered with scratches and bruises and he carried a gun.

"Where is he?" he shrieked. "Where is that no-good son of a . . ."

I didn't hear the rest. Something—it may have been the way he clutched an indicator in his other hand—told me that he was referring to me. I didn't know why he was so upset but I wasn't going to stay to find out. Not from

a semi-lunatic with a gun and the obvious desire to use it.

Abe met me just as I was about to enter the hotel.

"I've got your stuff," he said curtly. "Quick, come with me."

I didn't argue. Behind me the howling of a mob was beginning to vibrate the aluminium walls of the buildings and I followed the old man as if my life depended on it.

He led me to a shack at the edge of the spaceport and hid me under a clutter of boxes and containers. I crouched there while the mob went howling through the settlement and up to the spaceport. They even entered the shack and I heard one of them talking to Abe.

"We're going to lynch him," the man gritted. "We're going to string him up and leave him to kick. Sam's in hospital with three broken ribs and Fred had his nose torn off. Mrs. Edwards got clawed something awful and most of the boys were lucky to escape with their lives. I tell you,

Abe, we're going to get him for this."

"Bad, eh?" Abe made sympathetic noises while I tried to hold my breath and stop my heart beating. The man wasn't joking. He said something, swore, and became coherent.

"We're watching the space port and there's no other way he can leave the planet. When I think of the damage he's done . . ." He swore again. "Two years' work ruined! The fences down and the flocks running wild. Damn it, Abe! Why did it have to happen?"

"Well," said Abe thoughtfully. "I don't reckon to add to your misery, but if you'd have stuck to me . . ."

"So we made a mistake," said the man bitterly. He sounded as though he were almost crying with rage. "We won't make another one. Just wait until we get our hands on that slicker. Just let him wait!"

I stayed where I was for a long time after he'd gone, and when I finally crawled out

from under the boxes I was duly grateful.

Abe waved my thanks aside and stared at me. "I guess you know what happened, don't you?"

"No," I said, and I meant it. "Why they should blame me I can't imagine. How can I help it if their flocks run wild?"

"You sexed 'em," he reminded. "You or that gadget of yours, which is the same thing." He stared harder at me. "Don't you know about Grus?"

I didn't and he told me. It seems that the female is calm, placid, docile, and a heavy layer of the valuable eggs. Not so the male. The cock is filled with hate and fury and, when the glandular reaction triggers off, he grows a comb overnight, spurs in half that time, and sets out to make himself master of as many hens as he can. Two cocks in a compound act like crazy. Three or more can rip down the fences and attack anything which gets in their way.

They grow big, too, three feet high, and the miraculous thing about the entire episode was that no one had got killed.

No one yet, that is. They had slated *me* for that pleasure.

I shivered as I thought about it, and when I thanked Abe again I was sincere. So sincere that I offered him a thousand credits for his trouble if he would hide me until the rocket landed and I could sneak aboard.

The shock came when he refused to take it.

"Go on," I urged. "Take it. It'll leave me pretty flat, but what the hell? My neck's worth that much to me."

"That's what I reckoned," he said, and something about the way he said it made me thrust the money back into my pocket and thrust out my empty hand instead.

"Abe," I said. "You are a gentleman. Not many men would have saved me as you have done without thought of reward. Allow me to shake you by the hand."

He ignored my gesture.

"I've lost a lot of money because of you," he said pointedly. "If I'm caught hiding you they'll skin me for sure." He made a hateful gesture with his thumb and forefinger. "I reckon a man in your position would be willing to pay high for safe lodging."

And there it was.

Greed again. The horrible money-grabbing complex which affects everyone I know. I pleaded with the man and appealed to his humanity, but I was wasting my time. He even made me strip and almost found the folded bill I managed to hide in my mouth.

I doubt if anyone has ever paid so dearly for three days crummy lodging beneath a pile of boxes and the dubious pleasure of being smuggled aboard a spaceship disguised as a box of Gru eggs.

One thing I'm certain about. I'm never going back to Venus again.

It's too primitive.

Not only necessity is the

Mother of Invention

by JOHN KIPPAX

TO THE DIRECTOR:

Dear Sir,

As I know you will want an explanation, here are the facts as far as I can tell.

I was in a bar trying to look like part of the furniture, and I was sizing up the man who answered to the description. He was thin, maybe fifty, short and greying, with crumpled clothes and a lost expression. And he was next to me. Being alone, I was lost for what I should do next. When I did it, it was by accident. I knocked over his drink. I apologised, and bought him another rye, and then went on dividing my attention between the man and the door behind me.

Then he tapped me on the shoulder.

"Young man," he said thickly, "that was not a grave matter, but it was certainly a matter of gravity."

Again, I took him in. He was stewed. Definitely. From his pocket he thumbed a pair of pince nez, which he adjusted with exaggerated care. Then he repeated his remark: it could have been the alcohol which seemed to produce a slightly foreign accent.

I asked: "You meant that gravity gave it a pull?"

He nodded solemnly. "That's right," he mumbled. "Scientific joke. Thought you—looked bright—so I let you have it." He took a pull at his drink. "No charge at all." Swaying, he set down his glass and faced me. "You see . . . it was a p-pun . . . a funny . . . I m-made it up myself . . . n-not a grave matter, though certainly . . ."

"Yes," I broke in hastily. "Very good and scientific." Humour him, I thought, and watch the door, and wonder what the hell Benny is doing.

"Are you a scientist?" I asked.

He nodded in that vacant way. I was beginning to feel a little less nervous when, having accepted his invitation to a drink, I saw the wad of bills he took from his pocket. It was a pad about two inches thick, and seemed to consist of new hundreds. I felt tight inside. I made some guesses.

The bartender took the note and examined it critically. "Nice to have you with us, Mr. Rockefeller."

"Not Rockefeller. Skirmer—is my name."

"Well," said the man, rumpling the note, "you sure make 'em good."

That was right. Skirmer was his name.

When he got the drinks and the change Skirmer swept the money into his pocket with an air which confirmed my estimate of the amount of liquor he had on board. He found a stool and clawed it to him, put his backside on it and looked at me with boozy pleasure. Still no sign of

Benny. I *needed* him. What we had to do had to be done quietly.

"Yes," said Skirmer. "I am, no—I *was* a scientist."

"Retired?" I kept thinking about the money, and Benny—and the money.

There was an interval while he bought two more drinks.

"Retired? Well," he said, "I have retired from *project Brooklyn*."

"Why'd they fire you? Bad security risk?"

Despite the tactlessness of the question, he considered it without rancour. He seemed calmer, and more talkative. Still, you never knew.

"No—it was because I did not carry out my proper assignment."

I wasn't acting when I looked puzzled. I really *didn't* know the whole story.

"Though I was already a refugee from one kind of government," he said, "there is always a market for my kind of ability, so as soon as security cleared me, I got a job on *project Brooklyn*."

"What went wrong?"

"I will tell you. At first I was happy. Every week I sent in my reports, receiving in return my pay cheque and a little receipt for my work. We were all behind miles of barbed wire and armed guards, very claustro—clus—all shut away. Then as time went on, I began to wonder if they were really taking any notice of us, and my friend Tomasso and I decided to find out."

It was getting warmer—now he mentioned Tomasso.

"Instead of sending in our usual reports, one week we copied out the first ten pages of the *Text Book of Atomic Physics*—and sent *that* in. Sure enough, back came our pay and the receipt just the same. That decided us. We ignored the assignment from then on, and we began to do work which we knew was important. One was the work of my colleague's chosen field, and the other was mine—and we acted as assistants to each other. The 'reports' and the

pay cheques and receipts came and went regularly."

The money, I kept thinking, and Benny—and the money.

"Of course," he continued, "there were difficulties, and in particular I used to get nervous when we had to indent for fresh supplies of materials—for they did not tally with the official assignment at all. I feared that they would smell a mouse——"

"——A rat——"

"——rat at once. But no. We were safe. Such are the blessings of a competent bureaucracy. Then Tomasso had an attack of conscience. One day he looked at me very sternly and he said 'Henrik—for whom do we do this?' And I did not like the question at all. We both realised that what we were doing was of great importance, but I had to appease Tomasso by agreeing that if we were being paid by the Government, then we should report on what we were doing. So we told them the truth in our reports after that."

I watched him order two more drinks. A nut, was he?

"Then, when we were in sight of our respective goals, the almost impossible happened. Someone who understood read our reports."

"Amazing," I murmured, not humorously. Benny was *still* missing.

"We used to send in our reports on a Friday, and this official read them on the following Thursday, and by that time we had completed our work." He had been swilling the drink round and round the glass. Now he gave a short hollow laugh. "If you have sons, do not let them become scientists. Oh, the *shame* of it!"

"What was so wrong?" I asked, still being the sympathetic listener. "Did they jail you? They could see from your reports that——"

He waved me to silence.

"No—not *jail*. They put us in Almpoort hospital."

I knew Almpoort all right. "That's a special shop for——"

He cut in: "For lunatics? If you say so. They didn't believe us, they said, but I believe that they *did* think we had something, and that the hospital business was a way of getting us off their hands for a time while they investigated."

It all checked. I kept him talking "When did you go in?"

"Eight days ago."

"Then you were released——"

"I did not say we were released. Professor Tomasso and I got out yesterday morning, by means such as any schoolchild could have used."

He displayed a frayed smile.

"You escaped? Surely you don't think that you can get away with that?"

"We can. You see, Tomasso's invention is the supreme *getaway*—or *get into*, for that matter. When we escaped, we bought the parts Tomasso needed from a radio store, and we sat on a park bench while he fitted up a couple of models and tried

them out. They were very successful. Look." He took a small black metal box from his overcoat pocket. It had dials, and a red knob, and leads to which were attached a modified kind of headphone affair which held two plates which looked as though they were meant to fit over the temples.

"I have them both here." He displayed it proudly. "This is a Tomasso teleport."

"You don't say."

"I do say. With this you can transport yourself anywhere you wish. Doors, oceans, walls, steel partitions are no barrier."

"Where's Tomasso now, do you say?"

"I don't say." It sounded like Amos 'n' Andy.

He fondled the box lovingly. I began to think of ways of keeping him there while I scatter rang the joints for Benny.

He said: "And of course, you have had proof of how efficient the teleport is, haven't you?"

"Eh?" He had a good line here, no doubt, but I found difficulty in staying with it. He pulled out that thick wad of notes.

"Here is the proof. Half an hour ago, purely in the interests of science, I teleported myself into the bank two blocks away and took these."

I goggled.

"Straight through the walls and back," he said, with a satisfied smile. "That's *real* teleportation. Tomasso is a very clever man."

"He will patent this, of course?"

"Dear me, no," he answered. "This works on a new law of nature discovered by Tomasso, and you cannot patent a law of nature." He gazed at me steadily, and he did not seem far from being sober now—or was I drunk?

"We do not like the treatment we have received here, and we want no part of this country any more—neither Tomasso with his invention, nor I with mine. We have

decided to go somewhere else, to a far country."

"Where?" I asked.

He told me.

"No!" I exclaimed. "No!"

He shrugged.

"Why not? In any case, I can see that you are still sceptical about the teleport. Would you like a demonstration?"

"Right *here*?"

He thought about that.

"It *is* somewhat public," he said, "and of course there is the danger that, with even a little of the right sort of knowledge, you would be able to see how it works. So . . . the men's room over there would do, because it only has small windows, and the only way I could get out without you seeing me would be by the successful use of this apparatus. If I were to go in there, and you were to come in two minutes later and find me gone, would that be proof enough?"

I gave him a tolerant nod. Fortunately, I still didn't believe him, but I could still

have done with Benny being there.

"Very well, then——" He moved to the door, but I stopped him.

"What about *your* invention?"

His face assumed an expression like that on authentic images of the Buddha.

"Give me two minutes in the men's room for the teleport to work," he said, "and I promise that I will leave behind a note telling you what my invention is. Mine *would* be patentable, by the way. Agreed?"

I agreed. I saw him go in, a small, untidy figure, with a bulge in each raincoat pocket. "Nice knowing you, Mister Skirmer," I thought. Twenty seconds later I was in there after him. He was carrying on with the game even though he lacked an audience. The box hung round his neck and the plates were on his temples. He looked up, alarmed.

"You *still* don't believe!" he remarked. He didn't seem greatly put out.

"The part about Almpor, yes——"

"But the part about the teleport, no!" He dragged at a pocket. "Come here." He clapped the two plates of the second model on my head, and slung the box around my neck. I was in a spot. If only Benny, *or anybody*, would walk in. But no one did. My head was in a whirl. He finished giving me his crazy instructions "... and thought concentration will do the rest."

Delay him, delay him, *delay him!*

"Mr. Skirmer," I said, "what *did* you invent?"

"Oh," he said modestly, "I synthesised the uranium atom. Now, when you press the red button . . ." he added. Then he left. I don't think I remember hearing the door close.

I guess I don't have to tell you that I got here as quickly as I could. I don't think that your secretary will mind me typing this on her machine here next door to your office.

Though you, sir, as Direc-

tor of Almpor Special Hospital, are really a public servant, I'm in favour of you taking a long time for lunch today.

You engaged Donnison and Steinberg as two good private eyes for this job—quiet, efficient, no rough stuff, no questions. In future the D & S agency will be run entirely by Benjamin Steinberg, Esq., who can carry on a solo investigation into the Skirmer-Tomasso affair—and the best of luck to him in what time he has left before the FBI takes over.

Me? I'm resigning, checking out, giving it up. I'm still young, and I'd like to travel—maybe make Hawaii first stop, eh? That secretary of yours would make a swell travelling companion, but I don't think I have time to wait and ask her.

Have yourself a small ball at the next Hospital Board meeting.

Yours, etc.,

George Donnison.

P.S. I figure that this synthesising of the uranium atom must be quite something, too.



NON-FICTION

THE ATOMIC SUBMARINE, by Clay Blair, is a simply-written account of the concept, production and significance of the *Nautilus*, the world's first atomic powered submarine. There is a pleasant air of immediacy about the text, which entirely avoids the "chronicle" type of reportage; the introduction of dialogue helps enormously to make this a story of human endeavour rather than a mere technical dissertation. We wish, however, that a few more illustrations had been put in the book—though, no doubt, Security wrung its hands at the dozen or so actually published!

More than many books, this work will help to allay any fears that people might have that the human race is becoming automatic. Our machines may be marvellous, but there's an intricate com-

plex of human relations behind each one. *The Atomic Submarine* comes from Odhams Press (Long Acre, W.C.2) at 12s. 6d.

THE ROBOTS ARE AMONG US, by Rolf Strehl, presents the bogey of automation in its widest extent. The author points out what science fiction fans have known for years—that robotic mechanisms are not things of the distant future; they have been with us a long time. In this book are described and explained a wide range of automatic devices. But the whole theme of the book is the significance of such devices. Naturally, a great deal of the text is opinionated; that could not be avoided. And Strehl shows considerable shrewdness and acumen in his dealings with this thorny topic, even if his prognostications at times take

on aspects of the sensational. You will all want to read it. From Arco Publications (10 Fitzroy Street, W.1) at 16s.

THE FORESEEABLE FUTURE, by Sir George Thomson, Sc.D., F.R.S., is one of those beautifully sane and balanced books about the future which help to make the present so much more bearable. Here we have a most highly-trained and experienced scientist examining present trends and extrapolating them into the future—the very stuff of science fiction! Sir George's discourse ranges over energy and power, materials, transport and communications, meteorology, food, biology and some social consequences of all these developments. A final chapter deals with natural and artificial thought, and here we are treated to an unemotional account of the meaning of electronic brains. This book is definitely for those who want to think rationally about the future, rather than to have their emotions titillated. We thoroughly recommend it. From Cambridge University Press (Bentley House, 200 Euston Road, N.W.1) at 10s. 6d.

FIELDWORK IN BIOLOGY, by M. A. Besly and G. R. Meyer, was written for Australian students, but is equally suitable for people in Britain and America who like to have some purpose in their country walks. This is, in effect, an elementary textbook of practical ecology. It is slim enough to carry in the jacket pocket—which is a most important point. Its several sections deal with the freshwater stream, the marine rock platform, the estuarine flat and the garden as habitats for plants and animals. Plenty of tell-all illustrations sprinkle the text, and even the veriest beginner should have little trouble in getting many hours of interesting experience with the aid of this little book. From Methuen (36 Essex Street, W.C.2) at 4s. 6d.

SCIENCE NEWS No. 37 contains articles on fifty years of relativity, neutron and atom patterns in crystals, nature conservation and ecology, lighting and work, the automatic factory, and the usual excellent research report. Once again this is a splendid buy for only 2s. 6d. From Penguin Books (Harmondsworth, Middlesex).

THE "AEROPLANE" REVIEW OF HELICOPTER DEVELOPMENT, reprinted from *The Aeroplane*, is an exhaustive list, with pictures, of just about every helicopter there ever was, together with technical details about the various models. There are several cut-away drawings that expose every working part of the modern helicopter. Unfortunately, the book is in a rather unmanageable format—too large. Still, it is something of a bargain at only 3s. 6d. From Temple Press (Bowling Green Lane, E.C.1).

FICTION

THE LONG TOMORROW, by Leigh Brackett, is yet another of those "after-the-holocaust" stories. (Surely that idea is just about played out by now?) This takes place a long time after, when most of the people are too young to remember what it was like when there were cities. Cities have been illegalised. The whole point of the story is that some people want to build cities again, and they form a sort of "underground movement" to further this aim. Unhappily, the analysis

of characters' motivations and inter-relationships is hardly convincing. One of Brackett's less successful novels. From Doubleday (Garden City, New York) at \$2.95.

THE SPACE MERCHANTS, by Frederik Pohl and C. M. Kornbluth, is an excellent example of unprofitable collaboration. Both Kornbluth and Pohl write very well on their own. But this book, while making good reading, seems nowhere near the standard of either. It tries to be a three-dimensional essay into the schism between Commerce and Conservation. It partially succeeds. But it doesn't have real characters; at least, the characters have lots of unreal moments. This may well be due to the interplay of two authors. Anyway, see for yourself. It comes from Heinemann (99 Great Russell Street, W.C.1) at 10s. 6d.

MARTIN MAGNUS ON VENUS, by William F. Temple, is much the same as *Martin Magnus, Planet Rover*, by the same author, which we reviewed a while back. If you don't mind your science fiction cluttered up with fantasy (by

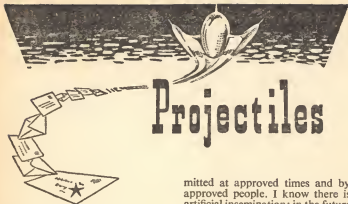
which we mean unscientific and implausible ideas and things) and your heart and mind are young enough, you will no doubt enjoy this story of fighting on Venus—with a side trip to the Moon and the easy solution of a problem that has “baffled astronomers for two centuries.” Not quite *our* meat, though. From Frederick Muller (110 Fleet Street, E.C.4) at 7s. 6d.

THE BIG BALL OF WAX, by Shepherd Mead, gets into the category of science fiction by one of the numerous back doors, but is highly acceptable all the same. The publishers call it “a story of tomorrow’s happy world”; whether you will agree about happy is a moot point. But certainly the book is commendably free from pessimism of the dank and drear type. It’s a book that you could say would be very funny if it weren’t so sad. It went down awfully well in the States, where it was acclaimed as the biggest belly laugh of the year.

In it, advertising is extrapolated to its giddy limits, and we are treated to a picture of the peculiar morality (in the

wide *and* narrow sense) that goes with it. The gimmick is a machine that you can strap on your head and which lets you really *live* the experiences had by others, from tape which was connected to their heads when they were having it. You can readily see what potentialities that has got—especially when you realise that the intensity of the feelings can be regulated by a sort of volume control! But, as with most things, it has its drawbacks. We strongly recommend you to get the book and find out what they are. Excellent light reading. From T. V. Boardman (14 Cockspur Street, S.W.1) at 10s. 6d.

RETURN TO MARS, by Captain W. E. Johns, continues the adventures of Professor Brane, who remains singularly unperturbed when firmly established scientific principles are flouted in front of his eyes. A book for young people who are not afraid to trifle with facts and well-founded theories—or for fantasy lovers, of course. From Hodder & Stoughton (Warwick Square, E.C.4) at 7s. 6d.



Projectiles

THE FUTURE

I'm an old woman approaching the end of the road. I give my correct name and address but if any of this finds print, please give it only as "one of our Australian readers."

I enjoy *Authentic*, but your writers all make the same mistake. They visualise a robot world and nothing more. There is no love in that world, no mating, no children to carry on where their parents left off. I am thinking of the pure and wholesome love that keeps our humanity alive. In that man-made world of the future there are no children; there are neither grass nor flowers, neither birds nor animals, neither joy nor hope. It's a world tenanted by robots, by zombies, by the living dead. And it is as dead as they are.

Your writers say folk in that world are permitted to marry under approved conditions, but parentage is frowned upon, per-

mitted at approved times and by approved people. I know there is artificial insemination; in the future we may breed test-tube babies, but you are more likely to breed imbeciles or cretins in that fashion. I don't think any *mother* would accept that method, though the man might. The mother *wants* the child to grow in her womb, to be part of herself. (I've mothered seven, so I know.)

I can't imagine a world without birdsongs, without sunrise and sunset, without dogs and cats and other animals, without trees and flowers, without children. Your writers generally tell of failure or of loss. Very few of them write happy, hopeful stories. In nearly every case the end is disappointment, and I wonder whether life would be worth living in the new world of science. I wouldn't want to. I'd rather sit in my garden with my pets and family, where I can watch the sunset and sunrise and hear the songs of the birds, and the gay laughter of my friends. The world of tomorrow is too bare, too lonely, too heart-breaking.

Mrs. L.—one of our Australian readers.

What a sad kind of letter, Mrs. L. You say you are nearing the end of the road; we hope you are not as near as you think, for you obviously know how to enjoy the beautiful things in life. But—we're afraid you are a little out of date, Mrs. L., and a little biased, too. Our writers visualise a robot world not because there is no alternative, but because we must find an alternative. We must solve the problems of rising populations in a way that does not destroy familial love. There are other problems that must be solved. The only solution any of us can see is a man-planned—not man-made—world. We must throw aside the easy muddle-along methods that let you sit in your garden, stroking your pet and watching the sun go down while hundreds of thousands dress in rags, feed on scraps and have their minds for ever wrapped in the obscurity of economic depression. Hungry men, ragged men, find difficulty in seeing the beauty of flowers. Fatigued women, undernourished women, have trouble in appreciating the alleged joys of repetitive motherhood. Couples in the agonising throes of incompatible temperaments are hard of hearing when you speak of marital bliss.

You have been lucky, Mrs. L. You have lived a long life in a part of the world where what you want is to be had for the asking or the working. There are other places where the only way to experience the good in life is to get to sleep and dream of them before you die so very young. In the robotic world of the future there will be no such places.

World-planning is full of dangers, to be sure. But world-letting-alone is full of misery—except for privileged places, like your gardens. And gardens hold so few.

UP THE PRICE!

May I take up your very limited time to confess my feelings to your undoubtedly welcome magazine? Thank you. It's always very pleasant to hear one's views being regarded to that of thousands of appreciative corresponders. May I say that on the whole all your best stories have been in the editions from Nos. 20 to 59. Between that selective period there has not been enough stories printed. I would be one of the first to say let's pay between 3s. and 5s. every week if the stories were of the same standard as were published between 20 and 59.

M. O'Sullivan, 235 Lavender Hill, Battersea, S.W.11.

You may be willing to pay 3s. to 5s., Mr. O'Sullivan, but a good many thousands of other readers would—quite justifiably, we think—consider such a price too high. Also, yours is rather a lone voice about story quality. Most people think our best stories have appeared in the last few issues. Still, we're glad to hear from you, all the same. How's the Mob getting along?

CAN LEARN

Authentic—the best of all science fiction magazines ever published! Yes, you certainly pack some material in, and good material, too. I find that from Authentic I can learn a great deal. I should be pleased to hear from anyone interested in science fiction at any time.

4145671, L.A.C. Spence, M. V.,
Block 20, Room 10, R.A.F.,
Nuneham Park,
Nuneham Courtney, Oxford.

Glad you like us, Mr. Spence, and we're glad that you're the progressive type of reader who likes to learn something about the world around him. Such are the backbone of Authentic's readership.

CONGRATS

Please congratulate Philip E. High for his story, *The Statics*, in No. 61. I liked it very much.

Robert Town, 5 Onslow Parade, Ferring Street, Ferring-by-Sea, Sussex.

Thank you, Robert. Congratulations duly passed on and received with comely gratitude!

SWAPS

I am willing to swap science fiction magazines for British Interplanetary Society Journals printed before the volumes of 1954 and 1955. I would be very grateful if you could publish this in your magazine.

Done!

OFF THE BEAM

On Friday last I saw a copy of *Authentic* and, thinking it may have been a rehash of a yankee old-time magazine, I bought it. Admire me, sir. I struggled through it. Now,

though you may be seriously tempted to burn this, I beg you in all fairness to read what I have to say. In stf I do not want to see a British magazine written and produced like an American one. After all, we have our own style, but you must admit that issue No. 60 of your magazine is a definite waste of time. Almost two-thirds of it was not fiction, and most of the fiction so old as to be not worth reading. *Firecracker Fool* was by far above the best you offered, but it's been done before. *Let There be Rain*, original. *A Hltch in Time*—when I have time to search among my list of *Galaxy*, I'll mail you the same story in its original and better form. *Down our Village*—how did Taite get away with that old one! *Decision*—Tubb has been selling bad stuff for so long now I had given up hoping to read one of his that was even written correctly! *Decision* was, but the whole thing was unnecessary. *Source*—why is it that all British sf abounds with the theory that atoms are solar systems? I have yet to read one that doesn't refer to this utterly silly idea that went out twenty-five years ago.

Victor Garvey, 22 Queenswood Rd., Moseley, Birmingham, 13.

We thank you for your comments, Victor, but—boy, oh boy—are you out on a lone, lone limb!

s f b c

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I received an "Apal" from you four weeks ago and am highly satisfied with results, having lost all desire for smoking. Kindly forward two more for my friends.

Mr. H. W., Bermuda.

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I bought an "Apal" from you six weeks ago and I stopped smoking the same day. Thank you very much.

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